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EXPERIMENTS WITH TOBACCO AT JAFFNA.

The experiments with tobacco at Jaffna began in October 1914 with a view to finding if any varieties of tobacco could be grown which would be suited to tobacco markets other than the Ceylon and South Indian.

A revision of tobacco duties in Southern India foreshadowed that the Northern Province was likely to be cut off from its chief and principal market for its main crop, and although relief was obtained on representations from the Ceylon Government, it was felt that experiments should be carried out to ascertain if a better type of tobacco could not be grown and manufactured for markets other than the South Indian.

The first experiments consisted of growing a large number of different varieties of tobacco with the view of ascertaining which, if any, were suited to the Jaffna conditions. Trials were also made with flue-curing to ascertain if a bright tobacco suited for cigarette manufacture could be produced.

The experiments with flue-curing demonstrated that at Jaffna cigarette tobacco with a sufficiently light colour could not be produced, while the variety tests indicated that the White Burley, Sumatra and Turkish types were worthy of extended trial.

Subsequent crops indicated that the White Burley was becoming acclimatized to the district in which the trials were being made and there was every indication that a satisfactory

type of tobacco was being produced. It was therefore decided to concentrate upon growing the White Burley type and the reports from the Imperial Institute published in the present number of the TROPICAL AGRICULTURIST are encouraging and indicate that a useful type of tobacco is being evolved.

During the past season, only White Burley has been grown and it is expected that 3,000 lb. of sound leaf will be available for the European market. Offers have already been received for this tobacco and they would appear to indicate that there is a decided promise of this class of tobacco being acceptable at remunerative prices in England at the present time.

The White Burley type has now become thoroughly acclimatized to the Jaffna conditions and is justifying the opinions expressed by MR. B. F. SCHERFFIUS, Tobacco Adviser, that a gradual improvement was taking place.

The chlorine content of the tobacco is still high, and therefore its burn is not so satisfactory as could be hoped for. Experiments have been made to ascertain how this excess of chlorine is to be accounted for. Analysis of the soil indicates that the excess is not due to the soil and analyses of irrigation water have given negative results. It can only be concluded therefore that the excess of chlorine is due to the strong salt-laden breezes that blow at Jaffna, and that therefore it will not be possible entirely to eliminate this excess of chlorine content.

This conclusion, coupled with the comparative failure of many cigar-types of tobacco, tends to illustrate that leaves of a cigar-type suited to European markets is not likely to be produced at Jaffna and that further trials should be made in other districts.

Arrangements are therefore being made for the continuance of the trials at Jaffna with White Burley for at least another season and for commencing experiments at Teldeniya with cigar and cigarette types under the supervision of an Adviser with American and South African experience.

FOOD STUFFS.

THE FOOD-VALUE OF THE GROUNDNUT.

A Press Note, dated 6th November, 1917, issued by the Government of Bombay, says:—

The groundnut, pea-nut, earth-nut, or monkey-nut *(Arachis hypogæa)* is a leguminous creeping plant indigenous to India. Although the fruit resembles a nut in that it contains fat it is really a legume. After flowering, the stalk of the plant bends over and enters the soil, where the seeds grow and mature. These seeds are contained in paper-like pods or husks, and there are usually two, but in some varieties four seeds in each pod. For commercial use these nuts have to be decorticated, and the shell is usually broken by special machinery. The inner red skin covering the kernel is then removed as completely as possible by a blast of air. The separated and cleaned kernels are ground up and subjected to hydraulic pressure to obtain the oil. This oil, known as Arachis oil, or *Katchung oil* in India, is obtained either by two, or sometimes three expressions.

The first expression of oil takes place at the ordinary temperature, and yields a cold drawn oil, which is nearly colourless, has a pleasant taste and odour, and forms a most valuable substitute for olive oil. It keeps very well. but on exposure for some time it has a tendency to thicken, and only then does it turn rancid.

The second expression is carried out at a temperature of 30° to 32° C., and the resulting oil may be used for culinary purposes, for the manufacture of margarine, as a lubricant, and also for burning purposes.

The third expression requires a still higher temperature, viz., 50° to 55° C., and this represents a lower grade oil, which is suitable for soap-making.

After expressing all the oil the press-cake is usually sold as a cattle food and is much valued as such, since it contains the highest protein content of all known cakes, and further has the advantage of easy digestibility. It is the purpose of this article to demonstrate the value of this cake as a foodstuff, and also the lines along which this industry may be developed with success.

In India, more particularly in the Bombay and Madras Presidencies, this groundnut industry is a large one, and before the war the nuts were exported from India in very large quantities, chiefly to France.

Here the oil was expressed (of which from 45 to 50 per cent. is present in the Indian samples) and used for soap-making, and the result of this was that groundnut oil, or Arachis oil as it is commonly called, was cheaper in France than in India. The true kernel of the Indian groundnut has the following composition:—

	Grammes per cent		Grammes per cent,
Water ...	7·5	Carbohydrates ...	15·7
Protein ...	27·5	Fibre ...	2·2
Fat (Arachis oil) ...	44·5	Ash ...	2·5

After the Arachis oil has been removed, and the resulting cake allowed to dry in the sun and finally reduced to a fine powder, this powder has the following composition :—

		Grammes per cent.			Grammes per cent.
Water	...	9·8	Fat	...	9·2
Protein	...	44·5	Fibre	...	5·2
Carbohydrates	...	23·8	Ash	...	7·5

It is evident from the analysis that this groundnut meal represents a highly nutritious food, not only for cattle, but for human beings. At present this press-cake is either used as cattle food or as a manure. Now this flour is not only rich in proteins which are essential constituents of all foods, but these same proteins have a peculiar composition, which make them particularly effective in supplementing food products of cereals whose proteins lack these special constituents. The proteins in our ordinary food are built up of certain amino-acids which are linked together just like the building stones of a house. Now all proteins contain these amino-acids, or building stones, but some essential ones are missing from the proteins of certain foods, and others again are present in varying proportions. Thus it has been shown that neither animals nor men can maintain their body, weight and proper growth and nutriment when fed on maize, or certain legumes. Similarly the proteins in wheat and barley, whilst sufficient to maintain body nutriment, will not suffice to promote growth. The first two have been shown to be due to the absence of a certain building stone, an amino-acid known as tryptophane, and the second two proteins to an absence of another building stone known as lysine. In order therefore to maintain proper nourishment and growth, the proteins taken in with the food must contain these two amino-acids, viz., tryptophane and lysine, and it is because meat proteins satisfy this condition that they form such a valuable food. Now it is well known that vegetable proteins will not replace animal proteins in a dietary, and hence a perfect food must be made up so that all these building stones are not only present, but also occur in suitable proportions.

Now, we find that groundnut cake, besides containing a high proportion of protein, contains certain amino-acids in quantity. These amino-acids belong to the same group as those found to be deficient in the proteins of wheat and barley, viz., lysine. By mixing groundnut meal with wheat flour and other cereals we are able to add these missing building stones. Again the particular proteins in the groundnut meal are deficient in the amino-acid tryptophane, so in order to overcome this deficiency we add dried milk in certain proportions. The groundnut cake when mixed with dried milk therefore gives us a flour of very high protein content, these proteins contain, as far as we know, all the various building stones necessary for growth and maintenance of nutrition. We find, however, that these two constituents do not go into solution very readily, hence the flour is mixed with sodium carbonate or bicarbonate, in which the other two constituents are readily soluble. The new flour thus consists of groundnut cake, dried milk, and bicarbonate of soda. The bicarbonate of soda acts also as a preservative, and assists in the process of baking. All these three constituents can be obtained in India in any quantity, and at a very cheap rate. The materials used may be prepared with the use of the existing mill machinery so that no additional outlay of capital is required.

Now, besides containing a large amount of protein, this new flour is rich in fat and mineral salts. Of the latter the most important feature is its richness in phosphates (phosphoric acid). In all foods, mineral salts cannot be replaced by any of the other forms of nutritive material present, e.g., proteins, fats, and carbohydrates. The carbohydrates and fats in the food supply the chief source of energy for the production of heat and work, and to a certain extent these may be interchanged, but neither of these nutritive constituents can replace proteins in the diet. The new flour is found to be deficient in carbohydrates so that for ordinary purposes of breadmaking it is suggested that ordinary wheat flour be mixed with it in the proper proportion (3-1) to make up this deficiency. The resulting product has now the following composition.

	Grammes per cent.
Water	6·8
Protein	15·9
Fat	10·3
Carbohydrates	66·0
Ash	1·0

This represents as nearly as possible a "perfect" food, and as such approximates very closely to a patent German food sold in India before the war at Rs. 6 per pound. This flour can be made in India at about one-twenty-fourth of the cost of the German product. If the wheat flour is not added, the new flour makes a valuable food for invalids and for patients suffering from diabetes and allied conditions.

Bread made from the new flour has been subjected to analysis, and sent out for trial. The results of these trials are very encouraging, as the bread is described as pleasant to the taste, easily manipulated, and possessing good keeping qualities.

The above account represents an attempt to bring forward evidence to show the possibilities of great improvement in the groundnut industry. Not only can the production of Arachis oil be improved, but the resulting groundnut cake has a very high food value. The paper-like husks serve an useful purpose for stuffing mattresses and cushions, and also as a possible source of cellulose (55 per cent) for paper-making, or as a source of fuel. The thin brown coating over the kernel may be used for manure, as also the ashes from the shells, if these are used as fuel. The leaves and branches of the plant form excellent fodder for cattle, and the groundnut cake also is a valuable cattle food. From the above account it will be seen that there is absolutely no waste in the groundnut industry, and for the oil alone the commercial value is great.

Now that the export trade is cut off, there should be a great demand for this oil in India as a substitute for olive oil, and there are several oil-crushing mills in this country capable of carrying it out. A glance at the figures of the Indian export trade before the war shows in what large quantities these oil-yielding nuts left the country. With the German sources of supply cut off by reason of our acquisition of most of their colonies in Africa, practically the whole trade in oil-containing seeds rests in the hands of the British Empire and America, two great allies. The whole groundnut industry in India has therefore a great future if properly worked, well supervised, and advantage taken of the means of utilizing all the various by-products.

For further details the reader may be referred to HANDBOOK OF COMMERCIAL PRODUCTS, INDIAN SECTION, No. 24, Calcutta, 1893; THE COMMERCIAL PRODUCTS OF INDIA, 1908, SIR GEORGE WATT; Article in INDIAN JOURNAL OF MEDICAL RESEARCH, Volume IV, No. 4, April 1917, page 786.

All inquiries on this subject should be addressed to the Secretary Indigenous Industries Committee, Secretariat, Bombay.—AGRIC. JOURN. OF INDIA, VOL. XIII, PT. II., APRIL 1918.

THE GROUNDNUT.

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INTRODUCTION.

An investigation of the possibilities of peanut cultivation, both as to production and market, together with numerous inquiries by farming interests, has led to this summary of the available information from departmental and other sources. It is only too apparent that our own information must be very largely supplemented by the accumulated knowledge of countries with an extensive peanut experience.

Free use has also been made of reports of field trials made by the Experimentalists at Grafton Experiment Farm (Mr. K. B. MACPHERSON) and at Yanco Experiment Farm (Messrs. A. N. SHEPHERD and J. M. PITT).

The peanut (*Arachis hypogœa* Linn.) is known in different localities as the groundnut, earthnut, goober, ground pea, pindar, and mandubi.

Its native habitat has been for a long period a matter for dispute among botanists, and has never been definitely settled. Some favour an African origin, but the weight of evidence brought by DE CANDOLLE* seems to indicate beyond doubt a Brazilian origin. It has never been found in a wild state, but the fact that six other species of the genus have been found wild in Brazil is significant. It became an extensively cultivated plant between the tropics of the eastern continents many years before its merits were recognized in the supposed land of its origin. Authentic records show it to have been an important article of food of the African natives in the seventeenth century, for it to have been included in the cargoes of slave ships as part of the provisions for the captive negroes. This has led many botanists to believe it is of Eastern origin, and to endeavour to trace its spread from Japan or China through India to Africa. If it is of Brazilian origin, then we might well ask how the species came to be distributed in the old world. DE CANDOLLE, than whom we have no more reliable authority, is inclined to believe "that the first slave ships carried it from Brazil to Guinea, and the Portuguese from Brazil into the Islands to the south of Asia in the end of the fifteenth century."*

One of the greatest peanut-producing countries of the present day is the United States of America. The commercial importance of the peanut there dates from between 1865 and 1875, although it was introduced in the early days of settlement. The development of the industry in the last forty years has been phenomenal, owing to the soil and climate, particularly of the eastern states, being admirably suited to its growth, and to the increasing demand for home consumption in the wide range of purposes for which it is adapted. In the last ten years the increase in production has been very rapid, and the most recent valuation in the peanut belt gave the holdings as worth £4,000,000. No less than 220,000 farms, aggregating 885,000 acres, are engaged in peanut production.

* L'origine des Plantes cultivées.

In 1908 the estimated value of the commercial crop was £2,400,000, and since then there has been an increase of 25 per cent.

With regard to the cultivation of the crop in Australia, practically nothing has been done on a commercial scale. In New South Wales the first introduction of American varieties by the Department of Agriculture was made in 1912, since which year they have been given a thorough trial and have proved beyond doubt that they are eminently suitable for our climate and soils. Excellent yields have been obtained, and when their commercial value is thoroughly realised and the proper labour saving implements have been obtained, etc., there should be a big future for the crop in New South Wales, Queensland, and Victoria. We should at least endeavour to produce £30,000 worth of nuts annually imported from China and Japan to supply the local domestic demand.

Although peanuts are usually regarded only as the roasted article, this is only one form in which they are used. They are used very extensively in the manufacture of confections and food products. It is, for example, one of the most important of the world's oil products, the United States alone utilizing nearly 1,000,000 gallons annually in the manufacture of oleomargarine.

As a farm product it is of considerable importance, for the entire plant is almost a balanced ration, being rich in protein, carbohydrates and fat.

BOTANY.

The peanut belongs to the order *Leguminosæ*, and is botanically named *Arachis hypogæa* Linn., in reference to the characteristic manner in which the fruit is matured underground. Among the members of the order it is unique, for no other plant possesses this peculiar habit.

It is an annual; and strictly speaking, its fruit is not a nut but a true pea. Its stems are procumbent, spreading or erect, angular, thick, pale-green and hairy, especially towards the extremities. The leaves are compound leaflets obovate, micronate, margin entire, ciliate when young, smooth and almost leathery with age, leaves closing slightly at night and in rainy weather. The flowers are small and yellow in colour, and carried at the end of a calyx tube with the ovary at the base. As soon as fertilisation takes place the petals fall, the peduncle, or short thick stem that carries the lower portion of the flower elongates and penetrates the soil, where the ovary at its extremity begins to enlarge and develop into a pale, wrinkled slightly curved pod containing edible seeds. If after the fall of the flower the peduncle does not, through accident, penetrate the soil it withers off and dies. The pod is woody and veined, the testa red or brown, and the embryo possesses two large fleshy cotyledons and a very short radicle. The roots of the plant are branched, but not fibrous. Characteristic of the *Leguminosæ*, it contains on its rootlets tubercles of various sizes. These tubercles or nodules contain myriads of microscopic organisms (rhizobia), which have the power of collecting the free nitrogen of the atmosphere and storing it within the tubercle, where it can be utilised by the plant or may supplement the nitrogen content of the soil. For this reason the peanut is a most desirable crop for soil renovating or improvement.

CLIMATE.

The peanut will thrive under a wide range of climatic conditions, but that best suited to the production of profitable crops is one in which maize will

grow luxuriously. Ideal climatic conditions are an early spring, a moderately hot summer of even temperatures with light rainfall, and a comparatively dry autumn, so that harvesting may take place with the minimum of injury to the nuts and vines. The crop is very susceptible to frost; a climate in which there is a season of five months free from frost is necessary.

Being such a largely cultivated plant and a native of intertropical countries, it might be regarded as only suitable for warm, moist climates, but it has been very successfully cultivated in the United States as far north as the southern portion of the States of Illinois and New Jersey. It has been noticed, however, that the climate affects the quality of the nuts, those grown in tropical countries having a considerably higher oil content than the same varieties grown in the temperate zones, and consequently are the more valuable for human food. Analysis of the same varieties grown in different latitudes would seem to indicate that "the content of oil is in inverse proportion to the distance from the Equator."*

That portion of our own State which most nearly approximates the ideal climatic conditions for the peanut is the North Coast. There are, however, other districts where it could be grown with a similar measure of success, particularly for oil production and for feeding to stock. In the United States the limits of profitable production are between the parallels of 26 degrees and 40 degrees north latitude, the nuts most in demand for human food being those raised between 36 degrees and 37 degrees. The whole of New South Wales lies within the corresponding parallels of south latitude. While taking cognisance of this similarity of latitudes, we must not lose sight of the modifications in climate due to the very different distribution of land masses and ocean currents in the two hemispheres. The Department's experience indicates the Murrumbidgee Irrigation Area and the North and Central Coast as climatically suitable districts, but it is exceedingly likely that the establishment of the peanut in those localities will lead to its profitable production in most parts of the State, with the exception of the highlands and southern slopes.

SOIL.

The class of soil that will produce the most marketable nut for roasting is a light, sandy, calcareous loam, greyish in colour, and with a well-drained clay subsoil. Darker soils contain a high percentage of iron or other mineral or organic matter, which may impart to the pods a dark stain and depreciate their market value. It is important to realize that this staining of the shell has no detrimental influence on the quality of the kernels. However, as is the case with all other crops, cognisance must be taken by the producer of market prejudices, and he can only hope that the future will see a more rational and scientific basis for market standards.

Although a sandy soil with a moderate amount of humus and rich in lime is regarded as ideal, the largest nuts and often the heaviest yields are obtained on clay soils containing a high lime content. Practically any soil that can be reduced to, and kept in, a friable condition will grow peanuts. It is essential for the soil to contain a fair percentage of lime in an available form, or unfilled pods will result. Stiff tenacious clays (which are invariably cold and inert), sour badly drained soils, and those which become so set and

*Farmers' Bulletin No. 25. U. S. Dept. of Agric.

firm on the surface as to prevent penetration of the peduncle and consequent failure to pod, are quite unsuitable for peanut growing.

In this State there is an abundance of soils that will produce to perfection the bright, clean pod required for roasting, and an even larger area is available for the production of the less attractive, though often larger nut, for use in the manufacture of confections, peanut oil, etc., or for use on the farm as food for live stock.

PREPARATION OF THE SOIL.

The factors chiefly influencing the preparation of the soil are its physical nature, the climate, and the time of sowing. The object is to have available at sowing time a deep, friable seed-bed, with 5 or 6 inches of well-worked soil. The cultural methods adopted to obtain these conditions will depend on the district. In the coastal districts, where the cropping is usually intense, only short periods are available for preparation. As soon as the preceding crop has been harvested, the land should be ploughed, care being taken to completely cover any stubble or organic matter, which must be well decayed before sowing is attempted.

The ploughing should be deep (6 or 7 inches), but the subsoil must not be brought to the surface. After ploughing, harrows and cultivators should be employed to work the soil, which can be allowed to lie idle until sowing time, when, if it has been set by rain, it should be cross-ploughed to a depth of 4 or 5 inches, harrowed and sown. If it is still in a fairly loose condition, it will only be necessary to cultivate to prepare for sowing, using the spring-tooth or disc cultivator. A handy implement which following the plough, turns, pulverises and levels the soil in one operation, leaving it in a good condition for sowing is the pulverising harrow. When the surface is cloddy or, in the case of sandy soils, rather too loose, a very effective implement that will leave the soil in a compact, fine, but not smooth condition is the packer.

It is essential that all possible means should be adopted to destroy weed growth, so that a clean fallow is presented when the seed is sown, otherwise the young peanut plant will be suffocated. In general it might be said, for the coastal districts, that the preparation necessary for maize is equally as efficacious for peanuts. In less favoured districts where the rainfall is normally meagre, more thorough cultivation is necessary to conserve the moisture that falls before sowing, and thus to augment the rainfall of the growing period.

In these districts early autumn ploughing is necessary, as is harrowing or cultivating after every rain of any magnitude in order to conserve all the moisture possible. At seeding time it is only necessary to cultivate and harrow to prepare the soil for sowing; in fact, ploughing at that time may result in serious loss of moisture by evaporation.

In districts where the rainfall is excessive for several months of the year, or where the drainage is poor, slight sowing ridges should be constructed in preference to drilling.

The peanut responds to thorough cultivation more quickly than most crops, and every effort should be made to produce a seed-bed characteristically fine, mellow and clean.—AGRICULTURAL GAZETTE of N. S. W., Feb. 2, 1918.

(To be continued).

CULTIVATION OF THE POTATO.

THE EDITOR.

Queensland Agricultural Journal.

(Continued from p. 224.)

CROSS FERTILISATION.

Mr. Findlay, the celebrated raiser of so many new varieties of potatos, in the course of a lecture before the Glasgow and West of Scotland Agricultural Discussion Society, spoke as follows on cross-fertilising and raising new varieties from seed :—

In the first place, I am distinctly of opinion that natural cross-fertilisation never took place in any part of the world at any period of the world's history. The blossom of the potato has a faintly sweet smell, yet it secretes no honey or nectar, and the pollen seems to be a bit too sharp and tasty to suit the palate of even the most voracious insect. In fact, it is highly poisonous, and I daresay that is where their objection comes in. I have seen now and again a bumble bee, no doubt attracted by the sweet smell of the blossom, alight on the edge of the petal, but never saw one explore the bloom, as is their habit where they expect to find either nectar or pollen. As the most casual observer will have noticed, the potato is an early closer, shutting up its blossoms between 2 and 3 o'clock in the afternoon, and, by reason of a certain twisting process, put it out of the power of any nocturnal moth or other insect to gain access to either nectar or pollen, even though they both were there. In the second place, I hold it is utterly impossible for the pollen of one blossom to be wide-borne, and so fertilise another, even on the same plant, one reason being that it is too heavy, and another, and more important one, being that it is a bi-sexual plant. Both the sexual organs are in the same bloom, the anthers or pollen cases being the male parts, and the pistil representing the female. And it further appears to me that, for some reason which I have not been able to discover, the potato plant is by nature opposed to cross-fertilisation, for, immediately the pollen in the anthers is matured, the bloom twists itself up harder than ever round the pistil, and no longer opens out to greet the sun. The bloom then no longer stands erect on its stem, but begins to hang down, swaying in the breeze. The pollen falls down into the narrow space formed by the twisting of the petals, all around the bulbous point of the pistil. The bloom thus remains for the matter of two days, and then falls off. Strange to say, the pistil only absorbs a very limited portion of the pollen. Yet what is left, so far as I have been able to discover, is perfectly inert. The potato, as I have already said, is, in my opinion, opposed to cross-fertilisation.

HOW HE RAISES FROM THE SEED.

Continuing, Mr. Findlay said, dealing with his method of working :— First I get a shallow seed pan, such as gardeners use, attend to the drainage, fill it up, or nearly, with well-decomposed leaf mould, to which has been added a little fine sand. I take a flat piece of wood, and beat it down fairly firm and level, and sow the seeds thinly and evenly over the flat and firm surface. That done, I take and sift, after adding more sand, some more of

this leaf mould. The sifting will remove all grit and stones. Now sprinkle a small portion over the seeds, but see that you do it evenly and not over thick—as near to an eighth of an inch as you can; give also a slight beat down. If the mould is fairly moist, you need not give any water for at least two days. Set your tray, to be out of the way of mishap, into the sunny corner of a cold frame. Put a piece of old newspaper or other paper over the tray, covering up with a piece of glass. Your great care now is to see that you do not allow the earth or mould to get dry; at the same time you must guard against making it too wet. In a week or ten days your seed should begin to braird. You must then give them more light and air. With average care, in a very short time you will have nice plants. When about an inch high, put them out in small pots singly. In another three weeks or so, if the weather is suitable, and the season far enough advanced, plant them out in the open where you mean them to be permanently. After this, your work is all in the ordinary course; only, remember this, you must take care when you harvest them to keep the produce of every plant by itself—I mean those you intend to grow again. Fifty per cent. or more will be of no use to go further with; and this 50 per cent. left year by year, you, if wise, will further reduce, until at the end of four years you have only one or two left as the sole representatives of your labour and care.

I am not aware that any attempts have been made by Queensland potato-growers to raise new varieties from seed. The potato plant flowers freely in this State, although the flowers usually drop off before the fruit or "apple" is formed. Where, however, the "fruit" as distinct from the "tuber" comes to maturity, there is no other reason why Australian growers should not evolve a prolific disease-resisting potato equal to some of those lately raised from seed in England and sold at such enormous prices. A correspondent of the Agricultural Gazette, London, has, through the inquiry column of that journal, elicited the following instructions for raising new varieties from seed:—

Those who desire to produce new varieties of potatos must first practise the art of cross-fertilisation, and must possess abundant patience. Like many other species which are not habitually multiplied by seed, the potato has a remarkable tendency to revert to the wild form. It may be necessary to cultivate 100 or even 1,000 seedlings, before finding one which is really worthy of a place among the better varieties already existing. M. Vilmorin says that in France the raising of seed potatos has been proceeded with in a somewhat haphazard manner; whereas in England, on the other hand, a more systematic method has been followed, richness in starch, excellence of flavour, power of resisting disease, with little tendency to develop haulm, being the characters we on this side of the channel generally seek. With regard to cross-fertilisation, it is rather a delicate operation, and needs time and attention to details. Directly the flower begins to open, the anthers must be removed carefully with a pair of fine-pointed scissors. This is necessary to prevent its own pollen from falling on the stigma and self-fertilising the ovary. It is well also to tie a piece of soft muslin round the emasculated flower. You have now to examine the flowers of the other variety which is to act as the male or husband. You may have to examine dozens of flowers before you will find one with its anthers bearing the

precious pollen in a powdery form, as some varieties are exceedingly shy pollen-bearers, owing to the energies of the plant being occupied in producing tubers at the expense of full development of its masculine attributes. When you find the pollen dust, collect it carefully on the point of a clean, dry camel-hair brush, and gently brush it on the point of the stigma or female organ that you had previously protected by means of muslin. You must, however, not do this prematurely, but wait till you observe the point of the stigma covered with a viscous-looking fluid. Then, and then only, the stigma is ready for the nuptial rites to be performed. Do not remove the muslin; this will serve to prevent the berry when ripe from falling and scattering its precious seeds. It will easily be ascertained when the berry is ripe, and then the latter should be gathered, placed in a box in a room to become thoroughly dry, after which remove the seeds, place them in a packet, and store them away safely till spring. But, when the seed has been saved after much pains and trouble, it will require some humouring when it is time to sow. Then the seeds should be sown in pans or shallow boxes 3 in. deep, containing an inch of drainage, then a layer of moss, and sufficient compost, equal parts of light loam and leaf-mould, to fill the box or pan to the top. Press the compost down firmly with a piece of board, and sprinkle some fine sand over it. Sow the seeds thinly, and then cover with an inch of finely sifted mould. The soil must not be too moist or too dry, as the seeds may die in one case or rot in the other. The seedlings should appear in about ten days, and they must have abundance of fresh air. Some writers suggest that the soil should be baked before sugaring it over the seeds, as the damping-off fungus is rather to be dreaded.

JUDGING POTATOS AT SHOWS.

Because a potato has a high-sounding name, and because it is a new variety, judges are satisfied to examine the interior and exterior of the raw potato and award it a prize or disqualify it according as its symmetry and healthy appearance appeal to their judgment. But does this examination satisfy the public? What the farmer wants to know is, its cropping power and its powers of resisting disease, and its early or late appearance on the market. What the housewife wants to know is, what are its cooking properties. It is of little importance that a certain potato exhibit has obtained first prize, for a crop must be a very poor one if, out of 5, 10, or 20 acres a bag or two of tubers cannot be obtained which will satisfy a judge in all that concerns the eye. But there are splendid-looking potatos which will not stand the cooking test. Some, when cooked, smell of the earth; others show none of that beautiful mealy appearance which is the characteristic of a good cooking potato. One that bursts its jacket when properly cooked, and shows a beautiful dry mealy exudation is surely preferable to one that is soapy or waxy. The market price of potatos depends largely on the quality of the cooked tuber. At some shows the judges are supplied with a plate of hot cooked potatos of each variety exhibited, and thus are able to determine what, after all, is the only true test of the value of a potato—its cooking qualities. Size is certainly not everything. It would be a move in the right direction if all potato exhibits at shows were accompanied on judging day by a dish of each variety cooked by an artist—for to cook a potato properly is a work of the culinary art not understood by all cooks.

QUANTITY OF SEED POTATOS REQUIRED TO PLANT AN ACRE OF LAND.

Those farmers who have been planting potatos year after year do not require to be told how many hundredweights or tons they require to plant a given area, but there are many taking up farming nowadays for the first time, and not being brought up to the business, have a very little, if any, idea of the quantities of any kind of seed required per acre for field crops. To such amateur farmers the following advice will be acceptable :—

The quantity required to plant an acre of land with potatos is, of course, regulated by the size of sets and the distance apart they are planted. There is a great difference of opinion as to the size of sets to use. Generally, when potato growers are discussing the size of sets to use, if they are asked what weight the sets should be, they don't seem to know what is meant. One man says he prefers a good big set, another man prefers a small set—neither man seems to know the weight of the sets he is advocating. It will perhaps be a guide to some growers to know that a potato as large as an egg weighs as much as the egg and an ordinary hen egg weighs 2 oz. Some growers consider a potato as large as a hen's egg will make two sets—this would be 1 oz. for each set. With potatos planted 2 ft. from row to row and 1 ft apart in the rows, it would take 21,780 sets, and the sets weighing 1 oz. each it would take 12 cwt. 0 qr. 17 lb. 4 oz. of seed to plant an acre ; this is about the distance apart generally adopted in small gardens. On the farm, potatos would require to be planted about 2 ft. 6 in. by 1 ft.—this would take 9 cwt. 2 qr. 25 lb. of seed ; with 1 oz. sets at 2 ft. 6 in. by 1 ft. 3 in. it takes nearly 8 cwt. of seed. The size of sets is one of the most important things the farmer that has to buy his seed has to consider. Seed potatos the size of hen eggs are the most economical to buy ; each potato will make two sets, and each set will grow as good a plant as a whole potato the size of an egg,

DISEASES OF POTATOS.

It is perhaps not stating too much to say that a very large percentage of disease is due to two specific causes, both of which could be prevented.

Unfortunately, the means of prevention do not generally commend themselves to the majority of Queensland potato-growers. An important fact which has been observed is, that when diseased potatos are planted, after the crop has been lifted, the remains of the old seed potatos, when brought to the surface of the ground, will produce a crop of fungus bearing myriads of spores. If such old seed potatos are kept buried in soil until the following season, and then exposed to light under favourable conditions, fungus fruit is still produced, and continues to grow so long as a scrap of the old potato remains. One often sees in horticultural periodicals, statements to the effect that, say, 10 acres of badly diseased potatos were ploughed in, not being considered worth lifting. Now, in the face of this, it is not difficult to understand where the germs that first infest a crop come from, and with the well-known necessary conditions of moisture and warmth, an epidemic breaks out at once. If the necessary conditions are wanting, however, the fungus, although present, cannot attack the potato leaves ; but the absence of disease does not necessarily prove the absence of the fungus, but only the absence of the conditions necessary to enable the fungus to attack

its host. In all probability, the fungus is always present in land where potatos are grown at short intervals, as in this State.

It is just as important to collect the old "sets," or the whole crop of diseased potatos, as it is to gather the sound ones. "But," says the farmer, "such work would never pay." It might not appear so, but eventually it would more than pay.

A second very fertile source of disease is due to planting infected potatos. Perhaps no farmer would plant obviously diseased potatos, but the danger arises when the potatos exhibit none of the external signs of the disease, but when cut, just show indications of the discoloured patches characteristic of the fungus. The obvious check to this source of danger is to cut all potatos used for planting, refusing those suspected of being diseased.

POTATO SCAB.

This disease, characterised by the presence of scurvy or scab-like patches on the skin of the potato, is very prevalent during certain seasons; and, although the edible portion of the potato is not injured, the market value is much depreciated. There is also another form of scab superficially resembling the one described, caused by an organism called *Oospora scabies*. The disease is prevented in both cases by steeping seed potatos for two hours in a half a pint of fomalin mixed with 15 gallons of water.

Another remedy is said to be efficacious, and that is, to dissolve 2 oz. of corrosive sublimate in 16 gallons of water; when fully dissolved, put the seed potatos in a bag and immerse them in the mixture, not leaving them to soak, but only long enough to ensure that all the seed is thoroughly wetted. Corrosive sublimate is highly poisonous, and must be handled carefully, a wooden vessel being used to dissolve it in. A potato affection was, in 1899, brought under the notice of the Queensland Department of Agriculture as occurring in the Gramzow and Alberton districts of Beenleigh, and it was found to be identical with the new disease of the potato plant whose nature and cause were first made known in 1894 by Mr. Henry Tryon, Government Entomologist. The disease was probably brought into the Beenleigh district many years since in seed potatos.

The symptoms of the disease are as follows:—

When the potato plant is in process of vigorous growth, and exhibits every evidence of health, it suddenly commences to droop as if lacking moisture; after a few hours it generally becomes flaccid, its branches bend downwards, and its leaves have their edges turned inwards so as to expose their under surface. These events happen in a few hours, and the plant thus smitten never revives, but gradually succumbs. On examination, the roots and tubers will be found, to all appearances, perfectly sound. But careful examination reveals a faint, ring-shaped line, which is seen on the section of a healthy tuber at a short distance within and parallel to the surface. This ring of the healthy tuber is more evident than usual from having become darkened in colour. Later on, an opaque, thick, white, tenacious fluid exudes in minute quantity from the eyes of the tuber; and it is this which causes the earth to strongly adhere to these points when the tuber is taken from the ground and permitted to dry. If kept perfectly dry,

the tuber usually undergoes no destructive changes; but if left in the soil, or placed in a damp atmosphere, destructive changes occur and eventually the whole potato becomes a mere mass of corruption. Mr. Tryon has described minutely the whole course of the disease in the issue of this Journal for July, 1899, to which I refer my readers.

TREATMENT.

As soon as the disease is recognised, every part of the affected plants should be removed, leaving not a particle behind. Then the ground should be opened up and lime applied to kill the plant microbe. Once the disease has shown itself, potatos should not be again planted for the succeeding crop on the same land, but two or more crops of, say, maize or brown millet, should be taken off. It should be noted that no plants of the same order should be planted on the infected ground, especially not tomatos.

THE IMPORTANCE OF SPRAYING POTATOS.

A few experiments conducted by the University College of North Wales in spraying potatos clearly emphasise the importance of conforming to this modern innovation in farm practice. These trials were carried out on different farms in the counties of Anglesey, Carnarvon, Denbigh, and Flint. In every single instance spraying gave good results, in some cases markedly so. In the matter of marketable potatos the average in the unsprayed crops was 7 tons 19 cwt. 96 lb. per acre. When sprayed once there was an increase of 1 ton 8 cwt. 91 lb.; sprayed twice, 2 tons 1 cwt. 26 lb.; but the late spraying did not effect such a large increase. There were fewer small potatos by the use of the sprayer, and less than half the diseased tubers when twice sprayed. The following directions have been issued by Professor Winter, indicating how the operations may be carried out:—

Directions for Spraying Potatos.

The following dressing is sufficient for 1 acre:—24 lb. sulphate of copper (98 per cent. pure), 30 lb. pure washing soda, 120 gallons of water. Washing soda is recommended in preference to lime. As in practice it will usually be difficult to dissolve the above quantity at one operation, we would suggest that the mixture should be prepared in a wooden vessel which will hold 25 gallons of water. First wash out this vessel thoroughly, and pour into it 15 gallons of clean water; then take 4 lb. sulphate of copper broken to a fine powder; place it in a canvas bag and stir it about in the water until the sulphate of copper is all dissolved. Next dissolve 5 lb. of washing soda in 5 gallons of water in a separate tub; then pour the washing soda solution into the sulphate of copper solution, aud stir well. The mixture should then be tested with blue litmus paper; if the litmus is turned red more washing soda should be dissolved, and steadily added until fresh litmus paper put into the solution remains blue. The quantity of material thus prepared is sufficient for one-sixth of an acre. As the nozzles of spraying machines are easily choked, the mixture should be poured into the machine through a canvas cloth. Spraying should be done twice, three weeks apart.

PREPARATION OF THE SOIL.

In regard to ordinary tillage cultivation, it is indisputable that land intended to bear a good yield can scarcely be brought to too fine a tilth. The rootlet will spread with greater rapidity, and be enabled to take up their nutriment better, if the soil is well pulverised.

If forest land is to be operated on, the first work necessary is, of course, stumping and clearing off the growing timber at least two months before the land is to be broken up. If the soil is black and heavy, as it is in many parts of the State, notably in the Lockyer district and on the Darling Downs, it should be broken up in the autumn, and allowed to be fallow until the end of June, when it should be harrowed down as fine as possible, and then well rolled. Then the land should be ploughed a second time, crossways, to a depth of 8 in. or more. By so doing the sour soil is turned to the top, and the soil which has been mellowed by sun and rain will be laid under.

Now let the land lie till the end of July. At that time, scarify it with a cultivator, and then give it a final ploughing and harrowing, when it will be in fit condition to be planted in September.

If new scrub land has to be dealt with, when the scrub has been felled and burnt off, the stumps will remain in the ground for some three years, when most of them will have rotted out or can more easily be removed than when they were green. But although the whole of the land is permeated with a network of roots, potatos may be planted by breaking it up in rows 2 ft. wide with a strong hoe, which easily cuts through the soft roots of the scrub trees. There is no danger in this case of stagnant water collecting in the rows as the porous scrub soil will drain off the superfluous moisture; hence potatos can endure far more rain in such soil than if planted on forest land or on black soil plains.

The season for planting having arrived, the next thing to consider is whether whole potatos or cut sets should be planted. This will all depend upon the season, whether the autumn or the spring sowing. For the winter crop whole seed is preferable, whilst cut sets are usually planted for the summer crop. I have already given the quantity of seed potatos required per acre as varying from 8 to 12 cwt., according to circumstances, distance between rows and plants, and the use of whole or cut potatos being the chief factors determining the quantity needed. When the seed is cut, it is well to sprinkle the sets with dry ashes, which will have the effect of hardening the cut surfaces and preventing the possibility of rotting should the seed lie over long in the ground before coming up. If, however, the seed has been properly sprouted before planting, there is little danger to be apprehended. The seed should be carted to the field in bags and placed at convenient distances along the rows, which are now being drawn to a depth of about 5 to 6 in., at a distance of 2 ft. 6 in. apart. The sets are laid in the furrow at from 12 to 14 in. apart, cut side down. The planted rows may be covered with the harrow. . . . .

AFTER-CULTIVATION.

Cultivation follows planting very closely, but interference is not needed, if the land is clean, until the haulms begin to show above the ground; then it is necessary to run a light, one-horse harrow over them, which can be safely done until the stalks are up some 2 in. above the ground, without any injury to the after-growth. This method will save a great deal of labour with the hoe, of which, however, there will be plenty needed before the potatos are fit to hill. The more work that is done among the roots in the way of loosening the soil, either with hoe or scuffler, between the rows, the more likely is the farmer to get a fair return for his labour, provided always that

the season be favourable. But even if the weather be dry, cultivation will be a great help to the plants by preventing evaporation of what moisture may be present in the soil. The farmer must, however, be careful to avoid disturbing the plant after the tubers are formed on the rootlets, and, therefore, he should not cultivate too closely.

As the haulms grow higher, fresh soil must be drawn around them ; in other words, they must be hilled up as the plants grow. This provides fresh plant food, supports the haulms, and keeps off superabundant moisture.

HARVESTING.

The first thing to make sure of before digging the crop is whether the tubers are sufficiently ripe to be lifted. The surest signs of maturity are the drying off of the haulms, and the firm setting of the potato skin. The winter crop may safely be left in the ground until the tubers are dead ripe, as there is little fear of any damage being done to them by flies and other insects ; but the summer crop runs great risk from the potato fly and from sun heat. It is therefore advisable to take the latter up as soon as the haulms begin to wither and turn brown. The skin will not be so firmly set, and hence the potatos will have a ragged appearance, and will not keep so well as if they had been allowed to remain in the ground until perfectly ripe.

Potatos may either be taken up with a digging fork, with a long handled shovel, with an ordinary plough, with a potato-digging plough, with the potato-digging machine, of which latter there are several in the market, and two—the Daniels and the Jackson—lately invented and perfected in Queensland by the inventors whose names they bear.

In the early days of potato growing in the light scrub soils, I found the long-handled shovel a better implement than the fork, no potatos being left in the ground; the labour also being less back-breaking. One ton a day was a fair day's work with this implement, and none of the potatos were injured by a tine of the fork being stuck into them. A swing plough will do the work more expeditiously, of course, and without the same risk of damage, but still there is always some damage done by scratching the tubers ; and, if the ground is at all weedy, many potatos will be left behind, which will have to be picked up by hand when cultivating for the succeeding crop.

In the absence of a regular digging machine, perhaps the cleanest way to take up a potato crop is to strip each side of the rows and then run a light plough down their centre, turning up all the potatos

Of the digging machines, the lightest and easiest worked by two horses are the two abovementioned. The Jackson machine simply digs the potatos, but does not grade them. Both machines are equal to digging 5 acres a day.

Where the land is free, and there are no weeds, such as fat-hen and thistles, the machines do excellent work, and are a great saving of labour. To make the best work, the dry top of haulms and all weeds and rubbish should be removed prior to the machine being put to work. Since the advent of the blight, even if the digging is to be done by hand, it is advisable to clear the " shaws " off, and burn to stop further infection by their coming in contact with the sound tubers after they are brought to the surface. In old times it was customary to make use of the haulms for covering heaps of

roots that had to be left in the field over night. But as it is almost impossible to be certain that no small spores of disease are lurking in the haulms, even in what are considered clean crops, it is advisable to run no risks and have the tops destroyed right away, fire being the best thing if the weather will allow.

STORING POTATOS.

When handling potatos for storing, treat them as eggs, careful handling means much as to the keeping qualities of potatos. When extra labour has to be employed in raising potatos, the greatest trouble is not slovenly digging; that can be rectified by after-cultivation with harrow and plough. After the cleanest of diggers there will be some left, so that it is only a question of a few extra bags to be picked up when ploughing. It is in getting men to sort them as they should be where the trouble lies.

There are several methods in practice in the matter of storing potatos; one is effected by putting a covering of some 6 in. of straw on a prepared heap of potatos, and, on the top of the straw, laying another 6 in. of dry earth. But experience has shown that such a covering is too air-tight, causing fermentation and decay. The method I adopted was to place potatos in a heap upon a high and dry patch of land and cover well with blady grass. By this plan, I succeeded in saving all my seed potatos in the sixties, at Oxley Creek, when heavy rains culminated in high floods. There is another way, which is to lay them on the barn floor and cover them with straw. This covering, whether out of doors or indoors, is necessary to keep them in serviceable condition. To heap up the summer crop, when first lifted, is a great mistake, as they are sure to heat and decay. In any case potatos should not be heaped up whilst in a damp condition, as they will very quickly become valueless. Stored potatos should be carefully sorted a week or so after they are taken out of the ground.

THE VALUE OF IMMATURE POTATO TUBERS AS SEED.

H. P. HUTCHINSON.

This is a general discussion of the experimental work relating to the use of immature potato tubers for seed.

It is concluded that immature seed is superior because (1) in using immature tubers for seed the largest tubers of the most productive plants will naturally be selected, thus resulting in increased yields, or, at least, in maintaining previous yields. (2) The cortex of immature tubers is thinner than that of mature tubers, thus lessening the check on the imbibition of water from without, which is necessary during the early stages of growth. (3) The amount and availability of the reserve plant food material may be greater in the immature tubers than in the mature ones. (4) The length of time of storage may materially affect the amount and form of plant food material, which would favour immature tubers due to the longer period of storage to which they are subjected. The use of immature tubers for seed also promotes earliness, vigor, and an ability to form tubers under adverse seasonal conditions.

Directions are given for procuring and storing immature tubers.—Experiment Station Record, Vol. 37, No. 4.

TOBACCO.

TOBACCO TRIALS AT JAFFNA.

The following report has been received on samples of tobacco grown during the 1917 crop which were forwarded to the Imperial Institute by the Department of Agriculture in June of last year :—

The samples of tobacco which are the subject of this report were forwarded to the Imperial Institute by the Director of Agriculture at Peradeniya, and are referred to in his letter No. 5018, dated 27th October, 1917. It was stated that the samples had been grown at the tobacco trial ground at Jaffna in 1917.

DESCRIPTION OF SAMPLES.

Five samples of tobacco were forwarded as follows :—

(1). "*Specially selected Trash Grade, White Burley.*" This sample weighed 1 lb. 2 oz. and consisted of five hands, composed of light yellowish or orange-brown leaves 17½ to 24 inches long and from 8 to 11 inches wide. The leaves were fairly thin but of fair strength ; they all showed some stains and many of them were badly marked.

(2). "*Specially selected Lug Grade, White Burley.*" This sample weighed 14 oz. and consisted of four hands, composed of light orange-brown leaves 21 to 27 inches long and 8½ to 14 inches wide. The leaves had fair body and strength but were slightly thinner than those of sample No. 3 (Leaf Grade). All the leaves showed stains and some of them were badly marked.

(3). "*Specially selected Leaf Grade, White Burley.*" This sample weighed 1 lb. 6 oz. and consisted of four hands composed of leaves from 21½ to 29 inches long and 8½ to 14 inches wide and of light to medium reddish-brown colour. The leaves had good substance and fair strength, and were of rather finer texture than the leaves of the bulk sample (No. 4). Most of them showed stains.

(4). "*White Burley (Bulk sample).*" This sample weighed 40 lb. and consisted of a number of labelled hands, composed of leaves from 22 to 30 inches long and 9 to 14 inches wide, mostly of a medium reddish-brown colour ; some of the leaves were similar to those of sample No. 2 (Lug Grade). The leaves were of good substance and fair strength ; most of them showed some stains.

(5). "*Turkish Cigarettes, imported seed.*" This sample weighed 2 oz. and consisted of a bundle of leaves varying from 6½ to 10½ inches in length and from 2½ to 5¼ inches in width. The colour was mainly a medium warm brown, with many dark brown discolourations principally along the midrib, whilst several leaves were of yellow or orange tint and a few greenish-yellow. The leaves were of fine texture and fairly strong ; but many had been badly attacked by tobacco grubs, and many also showed stains.

RESULTS OF EXAMINATION.

Analysis. The "bulk" sample (No. 4) of White Burley leaf was submitted to chemical examination with the following results, compared with those obtained for a previous sample of "White Burley Lugs" from Ceylon examined at the Imperial Institute (see Imperial Institute report, dated 23rd February, 1916):—

	Present sample of "White Burley" grown at Jaffna, (1917). per cent.	Previous sample of "White Burley Lugs" grown at Jaffna, (1914-1915). per cent.
Moisture	14·0	14·0
Nicotine	4·6	2·1
Nitrogen	3·4	1·9
Ash	19·0	24·6

Calculated to correspond to 14 per cent. of moisture. The ash was analysed with the following results :—

		Present sample	Previous sample.
Lime	Ca 0	34·7	33·4
Magnesia	Mg 0	7·0	5·5
Potash	$K_2 0$	14·4	16·3
Soda	$Na_2 0$	2·5	2·8
Sulphates, expressed as sulphuric acid ...	$S 0_3$	3·5	2·7
Chlorides, expressed as chlorine ...	Cl	14·2	15·0
Carbonates, expressed as carbon dioxide ...	$C 0_2$	15·8	11·3

Smoking trials. The four samples of White Burley showed very fair burning properties for this type of tobacco, but there was an almost entire absence of pleasant flavour. A mixture of the Burley tobacco with three times its weight of Nyasaland "Gold Leaf" was found to burn satisfactorily.

The sample of Turkish leaf, although of poor colour, had a fairly good flavour and "Turkish" aroma, but it did not burn well and the smoke was somewhat pungent.

COMMERCIAL VALUATION.

Owing to the inferior appearance of the Turkish tobacco it was not submitted for valuation, but the following reports on the four samples of White Burley tobacco were obtained from three firms of manufacturers and a firm of merchants.

(1). One firm of manufacturers stated that the colour and length of the leaves were both particularly good, although the stalk appeared to be rather heavy in proportion to the leaf which would cause a heavy loss in stripping. They considered that the tobacco would be useful for blending, and stated that at the present time there would be a good market for them, as this description of leaf is very scarce and much wanted. The present value in London of tobacco similar to these samples would be from 1*s.* to 1*s.* 4*d.* per lb., according to colour.

(2). Another firm of manufacturers reported that the colour of the tobacco was very good and the "body" a good average for Burley tobacco. They considered that the current American prices for tobacco represented

by the samples would be as follows :—

Trash Grade	...	...	...	7*d.* per lb.
Lug ,,	...	...	...	9*d.* ,, ,,
Leaf ,,	...	...	...	10*d.* ,, ,,
Bulk sample	...	...	...	1*s.* ,, ,,

(3). The third firm of manufacturers were of opinion that the tobaccos would not be very suitable for use in the United Kingdom owing to the woody stalks and the lack of flavour. The firm could not assign a value to the samples under present conditions, but they stated that in normal times the tobaccos might be worth 3*d.* or 4*d.* per lb. in London.

(4). The merchants reported that the tobaccos were well grown and handled, and quite suitable for the United Kingdom market. They valued them as follows :—

Trash Grade	...	...	...	7*d.* per lb.
Lug ,,	...	...	...	9*d.* ,, ,,
Leaf ,,	...	...	...	11*d.* ,, ,,
Bulk sample	...	...	...	1*s.* ,, ,,

REMARKS.

The present samples of White Burley tobacco are on the whole of good appearance and of much better quality than those previously received from Ceylon (see Imperial Institute report, dated 23rd February, 1916), the leaves being larger and superior in substance and texture. The burning properties were very fair.

The Chemical examination of the tobacco shows that they contain a high percentage of chlorides and are deficient in potash, which would adversely affect the burning properties. The amount of nicotine and nitrogen in the present samples are also unduly high, being much higher than in the specimens previously examined. The results indicate that the samples were grown in soil containing sufficient nitrogenous manure and an excess of chlorides but deficient in potash. The effect of these soil conditions on the character of the tobacco produced was discussed in the previous report to which reference should be made.

7th February, 1917.

FERTILIZER TESTS WITH TOBACCO VARIETIES ON COLLEGE SOILS.

G. PALAFOX Y DE LA CUESTA.

A series of fertilizer trials with five varieties of tobacco in the Philippines is reported.

All the varieties used responded creditably in height, vigour, and yield to fertilizer treatment. The largest grains were realized from the use of stable manure alone and legumes alone. From an economic standpoint green manuring with cowpeas and the use of stable manure was the cheapest source of material for obtaining increased production. Applications of commercial fertilizers by large growers are recommended.—Expt. Stn. Rec., Vol. 37, No. 4.

RICE.

ECONOMIC PLANTING OF PADDY.

H. C. SAMPSON.

Deputy Director of Agriculture, V and VII Circles, Trichinopoly.

Perhaps many of the readers of this Calendar are tired of seeing articles on this subject, but travelling about the country and noticing the paddy crops, the writer has observed that in very many tracts this system has not been adopted and in some places the ryots have never heard of it. This is strange, because every village munsif and every headmaster of a school has a copy of the Calendar sent to him each year written in his own vernacular. Perhaps the village munsifs or the school masters do not read these articles or perhaps it is that they do not tell others what they have read about. This is not right because prosperity of the village depends on the prosperity of the people who compose the village and if any means can be adopted, by which the cost of cultivation is reduced or the yield of the crop is increased, such information should be made public property. This is therefore, my excuse, in bringing this subject again to the notice of the readers of the Calendar.

For the last ten years this department has been advocating this simple improvement which is within the means of every wet land cultivator to try. It is more than that, it is to the advantage of every wet land cultivator to try this.

I will describe the system briefly and will then deal with the objections which are raised by farmers to the adoption of this practice.

The seed bed should be thoroughly ploughed, properly manured and levelled. If the dry method of raising seedlings is adopted the land should be well manured either by applying cattle manure or village manure or by penning sheep and cattle. If the wet method of raising seedlings is adopted, the land should be thoroughly puddled and manured by trampling in green manure leaves after which it should be carefully levelled.

For every acre of land to be transplanted not more than seven Madras measures of paddy seed should be sown in seven cents of land. With some varieties this area of seed bed will plant two acres and even more as in the case of those which grow very tall and tiller freely, but seven Madras measures is sufficient seed rate for all varieties. The seedlings should be transplanted at the proper time. For a four-month variety they should be planted when four weeks old, for a five-month variety when five weeks old, for a six month variety, when six weeks old. The seed bed should be well wetted before the seedlings are pulled out. These are big well grown seedlings and if the seed bed is not wetted they are apt to break as they have developed a firm root hold on the land.

The distance apart from planting the seedlings should be the same as for the ordinary method of planting. In rich soils these are planted singly wide apart and on poor soils they are singly planted close together. The after-treatment of the field is the same as in the ordinary method of planting.

In a few words the whole system is—raise good, strong, stout seedlings and when planting give them plenty of room to develop properly. The advantages are :—

1. You save seed.

2. When you plant singly the seedling becomes established sooner. It sends out roots in all directions instead of having to struggle for room with other seedlings planted in the same bunch.

3. The plant, being by itself, can utilise all the food in the soil instead of having to share this with ten or twenty or even fifty other plants. I have counted 56 seedlings in one bunch and one often comes across fields where more than 30 seedlings are planted together.

4. The singly planted plants being able to establish their roots more quickly than if planted in bunches, and being better grown in the nursery can withstand flooding better and can also withstand scarcity of water better.

5. As all the plants become established at the same time the crop ripens more evenly and fills its grain better.

The following objections are often raised to the adoption of this system :—

1. That unless the land is manured the soil becomes less fertile. Any person who makes this statement is not a farmer. Every farmer knows that if he uses suitable manure in proper quantity this will return to him at least 100 per cent. on the money spent on the manure.

2. That there is no certainty as to when irrigation water will be received and that if seed beds are thickly sown they can stand longer in the seed bed. This is quite true but it is only a lazy man's objection.

A thick sown seed bed uses from four to seven times as much seed ; that is, the seed costs from four to seven times as much. It is cheaper, although it involves a little more labour and supervision, to raise two seed beds sowing one, two to three weeks before the other. If water is received early then the first seedlings can be used, if late, then the second seed bed can be used. If the first nursery is used it is usually possible to sell the second nursery to some less careful farmer who is late with his planting and has not good seedlings of his own. It has the further advantage that the seedlings are strong and stout, whereas, those from the thick sown seed bed are pale and dwarfed.

3. That women find it difficult to transplant singly. If this is so then the seed bed is at fault, either it has not been manured properly or levelled properly or else the seed has been badly sown and not evenly distributed. There is no difficulty in separating well grown stout seedlings.

4. That the seed beds may be damaged by grasshoppers or other insects and that there may not be sufficient seedlings for planting. This is true, but if this is feared, it is still much cheaper to sow 10 Madras measures of seed on ten cents of seed bed to allow for this, than to sow 30-40 Madras measures as the case may be on seven cents of land. Further, if an insect attack such as this is feared, these insects are much more liable to do worse damage to the puny seedlings of a thick sown seed bed than to the healthy seedlings in a thinly sown seed bed. If the reader is still unwilling to take the risk of raising healthy seed beds, let him take the strong healthy seedlings from the margin of his thickly sown seed bed and transplant these singly in a small area. I think, if he tries this, he will satisfy himself as to the soundness of the advice now given to him.—Agric. Calendar, Madras Agric. Dept.

APICULTURE.

BEEKEEPING IN CEYLON.

(*Second Series.*)

A. P. GOONATILLAKE.

Beekeeping is becoming common in Siyane Korale East where the Mudaliyar as well as other leading residents have been showing the people the way. It is not an unusual sight now to see a hive or two in the houses of villagers between Attanagalla and Waturugama.

While passing through the villages I took the opportunity of examining some of the hives, and was sorry to find that though they were an improvement on the clay pot they were not properly constructed, and as a result the combs are found attached to each other owing to faulty spacing.

Hives, if they are to answer their purpose satisfactorily, should be constructed by an expert workman according to rigidly correct dimensions. They should also be made of good timber. Such hives can hardly be completed for less than Rs. 6/- which is a prohibitive price for a villager to pay.

The hives I have seen in common use are in my opinion, to begin with, too large, besides being faultily constructed by the village carpenter who cannot be trusted with work calling for strict accuracy.

I have kept (and am still keeping) bees in the large standard English hive as well as the small one which I consider best suited to the Indian honey bee, namely, one of the dimensions $10\frac{1}{2} \times 5\frac{1}{4}$ in.

My chief objection to a large hive for our local honey bees is that it encourages the swarming tendency. I have often removed queen cells from such hives, but was seldom able to prevent the bees from swarming.

In large hives there is also a tendency for bees to both breed and store in the same comb, so that in trying to remove the upper part in which honey is stored, the lower part, in which pollen and brood cells are found, are also removed; with the result that the extracted honey is not pure.

To obtain pure honey from a large hive one must resort to the use of the queen excluder and extract only from the combs in the chamber from which the queen has been excluded. A super is not practicable in large hives as it further encourages the swarming tendency, and prevents the hive being brought to its "boiling point."

By using the small-sized hive adopted by me, the swarming tendency is reduced to a minimum. When, however, any sign of swarming is observed, it is advisable to remove the queen cells and at the same time remove a comb with the queen and her attendant bees, and put them into an empty super inserting an empty frame or better still, one with foundation comb, in the place of the frame that has been removed from the main hive.

The super with the frame of bees and queen and the rest of the frames fixed with foundation comb may be placed on the main hive over a queen excluder. A "super" is thus easily established and the swarming tendency checked. Indeed it will be found that in a few days the excluder could be safely removed. In this way super over super can be established.

Of course, experience and careful handling are necessary for this. The beekeeper must be able to cut out the queen cells, which is in itself a somewhat delicate operation, as well as easily recognise the queen amidst the crowd of her attendants so as to remove the proper frame.

The objection may be raised that by restricting the size of the hive the breeding capacity of a prolific queen may be limited: but to this I would reply that there is no reason why the queen should not be allowed to lay in the supers till about 3 weeks before the honey flow, when she should be induced to go down to the parent hive. After the flow is over the queen may be given access to the supers again.

My experience is that the breeding space in an 8-frame hive of the size I have adopted is sufficient to keep two supers full to over flowing, with an ordinary good queen: but with extra vigorous layers I have used as many as five supers by allowing the queen to lay in the first super only.

What I favour is, therefore, limited space to begin with and the provision of extra accommodation by the use of supers.

While the free distribution of my book on beekeeping has encouraged many villagers to keep bees I am sorry to say that they have not set about the business in the correct way. One properly constructed hive is to be preferred to many bad ones. The capturing of a queen and the clipping of her wings must be done carefully so that she will not be injured. Rough and ready methods and haphazard handling of bees will never lead to success. Beekeeping is a "gentle art" and requires a delicate touch. With skilful handling there is no fear of bee-stings. Bees resent being hustled: and beekeeping teaches one patience and gentleness.

(*To be continued.*)

REVIVAL OF INTEREST IN BEEKEEPING.

Some years ago the Agricultural Society appointed a sub-committee with the object of encouraging the keeping of bees as a pleasant and profitable cottage industry. At that period the only experienced apiarist in our midst was Mr. Mathew Shanks, who kindly undertook to advise and assist beginners. Under Mr. Shanks's guidance some half a dozen amateurs made a start. At first the tendency was to keep imported bees—chiefly Italians—but the indifferent success that attended those early efforts resulted in concentrating the attention of local apiarists to the common honey bee of the East, *Apis indica*.

Though the Committee referred to has not met for a considerable time, the local interest in bees has slowly spread, mainly through the enthusiasm of pioneers in the field of apiculture, chief among whom was (and is) Mr. A. P. Goonatilleka, who by persistent study of the habits of our bees, and by making himself proficient in the handling of them, has induced a number of his neighbours to follow his example.

Mr. Goonatilleka recently published a Sinhalese handbook on beekeeping, two thousand copies of which he presented to the Society for free distribution to school teachers and others to whom the work was likely to prove useful. The publication of this work gave a further impetus to beekeeping as a village industry, and the present seems to be a suitable time for forming an association to foster the industry and direct it along proper lines. To this end the Secretary of the Agricultural Society has called a meeting of all those interested in beekeeping, with a view to launching the proposed association. At the same time it is intended to discuss the possibility of raising a fund, the appointment of an honorary inspector and instructor, the standardizing of hives and supplying them on easy terms, providing assistance in stocking hives, engaging the services of a man to capture swarms, to consider bee-pasturage and the cultivation of honey plants, study the seasons and the different strains of *Apis indica* and the raising of queens, keeping a register of beekeepers and working hives, circulating bee literature, publishing a monthly or quarterly leaflet, etc.

C. D.

PLANT SANITATION.

FIELD NOTES AND OBSERVATIONS ON BROWN BAST OF RUBBER.

W. N. C. BELGRAVE and F. W. SOUTH.

This disease has been attracting much attention recently both from planters and scientific workers in the Federated Malay States and Sumatra, and it is felt that some observations on the information gathered up to the present may be of service to planters in enabling them to decide what action to adopt towards controlling the disease on their estates. These observations are at present incomplete, as the necessary research work is not finished, and it may require some time yet before definite measures can be laid down. Certain points have, however, been determined fairly definitely from field observations ; these suggest provisional measures to be adopted according to the nature and intensity of the infection on each individual estate. The measures are based upon the assumption that the disease is due to a definite causative organism ; it may be pointed out that if the alternative theory of a physiological disease is correct, prevention may be expected to be extremely difficult, if not impossible. The conflicting ideas on the subject of this disease require to be cleared up, as soon as may be, and observations made up to the present suggest that a note of warning should be struck against the hasty adoption of too drastic measures, so far insufficiently tested, which may later prove to have been a mistake.

It must always be remembered that this disease, however undesirable from the point of view of the planter, is in reality practically harmless to the tree itself. No instances are known to us where trees have been killed by this disease ; on the other hand, many old trees are known which have been badly burred by the disease for years and are still vigorous and healthy in appearance except for the burrs, showing a good spread of branches and abundant leaves. As an extreme instance certain trees about 30 years old may be cited whose original main trunks have disappeared, so that they are entirely hollow at the base but are supported on and supplied by a cylinder of wood and bark that is entirely of burr formation. Therefore if infected trees are left standing, though the condition of their bark for tapping steadily deteriorates, there is no danger that they will die ; moreover, some satisfactory method of treatment may later be devised ; consequently it is not desirable to cut out these trees too hurriedly, unless thinning out operations render such action suitable, especially when it is remembered that attacked trees are often the healthiest and best grown in the field.

Observations so far lead to the conclusion that the causative organism does not fruit on the surface of the bark of infected trees, so that these *when untapped on infected areas* are probably not a source of spread of the disease. Therefore there is no reason for their removal on this account.

SYMPTOMS.

The first symptoms of this disease in the field, in fact the only sign that the tree is diseased and therefore the only means of recognizing it, is a

decrease in the yield of latex followed by the drying up of all or part or different parts of the tapping cut. This symptom alone must not, however, be taken as conclusive evidence of the presence of brown bast. To determine if brown bast is present or not the tapping cut should be freshly opened and should be carefully examined; at the same time it is useful to cut into the bark just below the tapping cut with a gouge. This cutting must be done carefully. The first cut may go in to a sufficient depth to remove all the dry outer dead tissues and about half the thickness of the cortex and then successive cuts should remove comparatively thin layers because the infected layer is often very thin and deep cutting may remove it. If brown bast is present a layer will be found, usually well underneath the pinkish cortex, which shows brown, grey, or greenish lines and patches dirty and water-soaked. The recently opened tapping cut shows this layer as a row of discoloured spots and lines lying about 1/8 inch outside the wood. The depth of this layer varies and in some cases it almost coincides with the cambium, though usually it is placed as stated. Beneath it the cortex is healthy and gives a little latex and outside it also the cortex appears normal. This discoloured layer is usually found in early stages just about the position occupied by the outermost latex tubes. As the disease progresses the discolourations become deeper in colour and often contain darker streaks where cells have died, while at the same time the area of bark infected increases considerably in size in all directions but specially vertically; later the discoloured layer becomes continuous along the whole length of the tapping cut. The cambium forms healthy tissue beneath the diseased layer and forces the latter outward causing vertical splits to appear in the bark. At this stage there is usually a considerable return of latex and the inner healthy layer will have been found to have increased in width. Later, however, a new diseased layer of diseased tissue is continued and it eventually comes away as a thick slab of dry outer bark, leaving a slight but definite depression, the surface of which is of a fresher colour than the surrounding bark. If the cortex is cut into on such a depression the peculiar streaky brown colouration which may be described as a "pepper and salt" appearance will often be found in a definite layer not very far below the surface showing that the disease is still present.

At different stages in the development of the disease, but usually after the first partial return of the latex, burrs begin to form in the bark. These may appear comparatively soon after a definite infection has been observed, or they may be delayed for some months. They gradually increase in size until at least the whole tapping section, sometimes all the bark round the bottom 2 or 3 feet of the tree finally become so badly burred as to be no longer tappable. Were it not for the roughness of the burred surface tapping would usually be possible since the bark of burred portions generally contains an average amount of latex.

At this point it should be noted that the disease makes its appearance at one or two distinct points on a tree, either at the tapping cut, or at the collar. The symptoms vary somewhat in each case and the matter is important from the point of view of treatment. When the infection has commenced on the tapping cut it will be found in early stages that the bark is only affected for a limited distance below the cut and for a smaller distance in the renewal above the cut. The collar is free from the disease. It will also be found

that the infection is confined to the section of the tree that is being tapped. As the disease progresses it spreads downwards more rapidly than upwards and eventually reaches the ground level. Splitting of the bark shows first just below the tapping cut as would be expected and burring commences at or just below the cut. A prominent burr development forms both above and below the cut, usually extending further down the tree than up. In this stage tapping cut infections are easy to identify; in earlier stages it is necessary to examine the cortex at intervals down the trees to the ground to determine if the collar and lower parts of the bark are healthy. It has been observed that the tapping cut infections frequently remain confined to one tapping section only, especially if the vertical channels have been cut fairly deeply. It may remain confined to the one section for some time.

Collar infections commence at the soil level or just below it and spread upwards. As the disease spreads more rapidly in some parts than in others, the upper margin of infected tissue is uneven and promontories or finger-like projections of diseased cortex are formed. As the tapping cut moves down the tree it may one day cut through one or two of these projections and comparatively suddenly show one or more dry or nearly dry spots, though just previously the latex flow may have been satisfactory. The lower down the cut moves, the longer become the dry lengths of the cut until finally practically no latex is obtained where the cut runs entirely through diseased bark. Collar infections often spread some distance down the main root and also out along any superficial lateral roots arising near the infected part. On lateral roots the infection may be confined to the bark on the damp under surface where they are in contact with the soil. In these cases, the disease is more liable to spread all round or nearly all round the tree than in the case of tapping cut infections, especially in virgin bark free from vertical channels. Such infections are apparently as common on virgin bark on newly opened trees as on renewed bark and one instance is reported where a young untapped tree was infected. Bark splitting and burring in these cases commence near the soil level and spread upwards; bark splitting may often be seen on the exposed surfaces of lateral roots near the trunk.

Apart from any other considerations, the fact that this disease may make its appearance at either of two different and definite places on a tree, the collar or the tapping cut, appears to the writers a strong indication that it is caused by a definite organic parasite. The theory suggested by these facts is that a soil organism enters trees at the collar possibly through the lenticels or through small wounds and is then conveyed from cuts running through infected bark by way of the tapping knife and the coolies' hands to cuts on other trees. At present this is merely a theory, however, and awaits the results of further investigation for proof or disproof.

Trees are often found which appear to have dried up owing to causes other than brown bast. Such trees show no discolouration in the cortex and the drying up is often only temporary. They should be left untapped until the latex returns.

TREATMENT AND PREVENTION.

Practically all the methods suggested for the treatment and prevention of this disease are still in a purely experimental stage; some of them are both expensive and drastic. So far nothing recommended for trial has been conclusively proved successful either as treatment or preventive. Under these circumstances caution is advised. Empirical measures may prove successful, but equally or more probably may prove wasteful and harmful. The period of waiting while the necessary knowledge is being obtained may, however, be bridged over by certain palliatives and by the more harmless and inexpensive empirical measures suggested by field observations and recommended by various writers on this subject.

(a) TAPPING CUT INFECTIONS.

When these are recognized in an early stage so that the disease has not spread more than about 3 inches below and one to 2 inches above the cut, it would probably be found beneficial to adopt the stripping method described by Magill in the Malayan Tin and Rubber Journal, 30th July, 1917. Two vertical cuts should be made on either side of the infected area; their positions usually coincide approximately with those of the vertical channels, a horizontal cut should be made above the area and another cut should be run round below it. All should include a small margin of healthy tissue and should extend down to the wood. The bark should then be eased away from the wood from the bottom, upwards, as the renewing bark does not come away easily. Care should be taken in levering up the bark along the edge not to press the knife into the wood below more than is unavoidable. When the edge has been freed it should be taken firmly in the fingers and the whole piece of infected bark should then be stripped off. The exposed surface must not be touched and must be shielded from the sun and wind for a few days with a piece of damp cloth stretched on wires so that it cannot touch the exposed tissues.

An alternative course is to scrape the infected surface, having previously isolated it by means of narrow cuts with a gouge extending down to the wood. These cuts should be made in the same positions as those described above for stripping. They must be kept open and should be painted with a mixture of 50 per cent. Tar and 50 per cent. Jodelite applied with a fine brush. Scraping may be comparatively superficial removing only the outer bark and very little of the cortex. In this case the surface should be painted with a 15 per cent. solution of Izal in water or 20 per cent. Brunolinum in soft soap and water. This method does not seem likely to give satisfactory results judging by experiments that have been tried. Preferably scraping should extend down to the point at which latex is just commencing to ooze out, and a weak disinfectant, 2 or 3 per cent. Izal or 5 per cent. Brunolinum solution should be applied. This method is more likely to be successful, but experiments indicate that if even a small piece of infected tissue is left the disease is likely to spread again from it.

Probably the best course is to isolate all the infected patches by means of narrow cuts down to the wood as described and then to try the other measures on a limited number of trees, at least as a commencement.

When the diseased area has been isolated as described a fresh tapping cut may be opened on the tree, preferably on the next oldest tapping section. It is preferable to place this cut at such a height as will allow of a proper renewal without including the original diseased area in the intended scheme in case this area fails to recover satisfactorily. New cuts on infected trees should not be opened unless preventive painting is adopted.

When trees are in later stages of disease resulting from tapping cut infections, the diseased area, usually one tapping section, should be isolated as described above by opening up the vertical channels down to the wood and putting in the necessary horizontal cuts above and below the infected bark. Stripping and scraping being uncertain in their results cannot yet be recommended generally. The cut should, in these cases, always be transferred to a new section. The removal of a strip of bark 3 or 4 inches in vertical length recommended for early stages of infection is very different from removing a strip 2 or 3 feet long as is necessary in older cases.

The proportion of trees infected at the tapping cut to those infected at the collar varies greatly from one estate to another. In one case noted about 30 per cent. were cut infections and 70 per cent. collar; in another case 70 or 80 per cent. were cut infections and only about 20 or 30 per cent. collar. It happened that the trees on both estates were much about the same age, 7 to 8 years and the types of soil were not very different. Whenever even

a few definite tapping cut infections occur, preventive daily or alternate daily painting with 5 per cent. Izal or "Formalin-bisulphite" solutions should be undertaken at any rate on all the infected tasks. Even if collar infections only occur and it is intended to continue tapping the infected trees, preventive painting should be done as a safeguard.

One other point requires mentioning. When a tree tapped on the V system becomes infected with either brown bast or "black-stripe" disease, both sides of the cut are almost always affected. This leaves only half the tree for further tapping. In the case of brown bast at any rate, requiring isolation methods and perhaps more drastic treatment, there may be too small a portion of uninterrupted bark left, if even one more quarter is tapped. Therefore it would seem advisable to drop V tapping and substitute a quarter system on estates having more than 2 or 3 trees per acre affected with brown bast.

(b) COLLAR INFECTIONS.

These are usually more extensively diseased before the attack is discovered. If the disease has not spread far round the tree, the infected bark may be isolated by gouge cuts as described above, but care must be taken to make sure how far round it has extended. If only a small area is affected, a new tapping cut may be opened as described, if preventive painting is done. More usually, however, the area is fairly extensive and it is wiser to isolate it and leave the tree alone in case measures may be found in the future to render it useful again. On smaller patches of infected bark, scraping may be done, at any rate experimentally, or even stripping if the patch is not too large.

If thinning out has not been completed, trees affected with brown bast at the collar should be removed. If it has been finished, such trees may remain as stated above.

(c) BURRS.

Burred trees should either be removed in thinning out, or when this operation has been completed should be left untapped. Possibly they may have to be removed in the end, but they might wait until something more definite is known of the possibility of treating them. In this connection it should be remembered that burred tissues often contain latex in paying quantities as stated above and that excision with a tapping knife is not the only means of obtaining it.—Agric. Bull. of the F.M.S., Vol. vi. No. 4.

DISEASE INVESTIGATIONS IN CEYLON.

The following is an extract from the Quarterly Report of the Botanist and Mycologist for the first quarter, 1918 :—

Among the new diseases recorded during the last three months are a fruit rot of Tomato caused by *Vermicularia Capsici*, Downy Mildew (*Peronospora parasitica*) on mustard, Wilt (Bacterial) of Fennel.

Investigations have been made on the damping off of seedlings at Hakgala, a die back of Cedrela toona at Haputale, Casuarina disease from Mauritius.

The false smut of rice has been sent in from Badulla. This is the first record of this disease in Ceylon. It is known to occur in almost every rice growing country, but does very little damage. Only two diseased heads were sent in, and a further search did not reveal any more. The paddy was grown from local seed.

An extensive development of *Fomes semitostus* on stumps and logs of Bois immortelle (*Erythrina umbrosa*) was recorded from the Matale district. The trees which had been planted as shade in cacao in the eighties had been ringed several years ago when hevea was planted through the cacao, and had recently fallen.

SOILS AND MANURES.

THE GROWTH OF INTERNATIONAL TRADE IN MANURES.

PROFESSOR JAMES HENDRICK, B.Sc., F.I.C., UNIVERSITY OF ABERDEEN.

(Continued from page 244).

PHOSPHATIC MANURES.

Phosphatic manures are the most extensively used of all artificial fertilisers, and give rise to a greater volume of international commerce and to a more wide-spread manufacturing industry than any others. The earliest distinctively phosphatic manure used was bones, which contains a little nitrogen as well as its phosphate.

Bones were used to a certain extent as a fertiliser long before 1840, and there seems to have been in 1840, an industry in this country in bone manures, almost as great as that which exists at the present day. JOHN SHIER, the first Fordyce Lecturer in the University of Aberdeen, states in an edition of SIR H. DAVY'S 'Elements of Agricultural Chemistry,' which he published in 1844, with additions and notes: "Bones have for many years been imported into this country from almost all the principal ports of North Europe, and for some time, though in less quantity, from the south of Europe, and even South America. MR. NEALE'S report on Agricultural Produce and Shipping in Northern Europe, printed by order of the House of Commons in February 1842, furnishes some data from which an idea of the extent of the trade in this article may be obtained. Of eleven ports reported on, two were found to export none. Concerning Hamburg, which is known to export largely, no information could be obtained; but the remaining eight, namely Rotterdam, Bremen, Kiel, Lubaek, Rostock, Stettin, Dantzic, and Elsinore, the total export amount to 13,084 tons." He also states: "During the year, from 1st June 1840, to 1st June 1841, there were imported into Aberdeen from foreign ports 4,355½ tons, and on an average of the last six years 3,461 tons annually." Bones still continue to be a very popular manure in the Aberdeen neighbourhood. Statistics kindly supplied by the Harbour Treasurer show that during the ten years, 1907-1916, the average annual import of bones, bone ash, and bone meal through Aberdeen harbour was 7,246 tons.

This interesting reference also shows that at that period we drew large quantities of bones from German ports, and presumably at that period German agriculture, which was in a very backward condition, did not use bones to any great extent as a fertiliser. It was about this period also that the famous German chemist LIEBIG accused England of rifling the battle-fields of Europe and the catacombs of Sicily in her insatiate search for bones, which she "squanders down her sewers to the sea."

We probably still use bones as large as ever, and many of our farmers have greater faith in them than in any other manure. All other manure-using countries also use bones, and no doubt so far as they can be obtained

they are fully utilised for fertilising the soil. Though the import and export of bones make a respectable show in the world's trade returns, they are quite a small and secondary matter compared with such fertilisers as mineral phosphates, superphosphates, and basic slag, which are handled by the million tons, whereas in the case of bones the greatest figure which appears in the returns is a little over 100,000 tons for the export in certain years from India. Bones are also largely exported from the Argentine and from Russia, The mean export from India for the five years, 1908-1912, was 87,376 tons per annum, and little was used in the country itself. Table IX. shows the exports for 1912 and 1913 from the chief exporting countries, and the imports into the chief consuming countries. The figures include not merely raw bones but treated bones, such as steamed bone flour and bone ash.

TABLE IX.

EXPORTS AND IMPORTS OF BONE MANURES.

(Metric Tons).

	Exports		Imports	
	1912.	1913.	1912.	1913.
British India	111,990	107,105	52	243
Argentine	31,878	31,611	—	—
China ...	29,976	33,682	—	—
Russia ...	43,228	39,723	668	2,527
Germany ...	36,795	33,125	53,185	55,326
Belgium ...	16,365	22,748	41,656	45,509
France ...	11,939	13,985	38,987	39,395
United Kingdom	—	—	41,862	41,336
United States	—	—	34,703	35,173
Japan ...	—	—	39,302	47,894

Belgium, France, and Germany are both importers and exporters, as they import large quantities of raw bones and export treated bones. In all the countries which use bones extensively large quantities of home bones are consumed in addition to the imported bones. In the United Kingdom it is estimated that the home bones amount to between 50,000 and 50,000 tons per annum. The total supply of bones of all kinds, including both raw and treated bones, available for use as manure, amounts therefore to about 100,000 tons per annum.

Great as are these quantities of bones, they are small in comparison with the mineral phosphates which are used in the preparation of fertilisers. As already stated, the use of mineral phosphates for the manufacture of superphosphate started soon after 1840. In the early years of the manufacture coprolites, obtained from Cambridge, Suffolk, and other English counties, were used. The production of coprolites in England attained considerable dimensions after the middle of last century, but fell away again to almost nothing during the last quarter of the century. No figures are known to the author for the years before 1874, but Mr. G. Campbell Arnott, the Technical Adviser of the Fertiliser Manufacturers' Association, has kindly supplied statistics of the output of phosphate of lime in the United Kingdom from that year onwards. These show that for the five years, 1874-1878, the average annual production was 156,186 tons. It fell to 26,852 tons for the five years, 1884-88, and to 1,950 tons for the five years, 1894-98. Since 1900

the production has been practically nil. Phosphorites, apatites, and phosphatic guanos also were imported from France, Spain, Germany, Belgium and other parts of the world, and used for preparing dissolved manures during the early years of the industry. In recent times, however, the world's supply of raw phosphates has been drawn principally from two regions—the United States and North Africa—though important quantities have also been produced in France and Belgium and in certain islands in the Pacific Ocean, and small quantities in a number of other countries. Raw phosphates are found very widely distributed throughout the world, and there are few countries where some kind of phosphatic rock cannot be obtained. The industry has, however, in recent years concentrated in a few centres where great supplies are obtained comparatively easily and cheaply, where transport is good so that the rock can readily be brought to the world's markets, and where the quality of the phosphate is such that it is suitable for the preparation of dissolved manures. English coprolites are no longer worked, because the supplies are limited and expensive to obtain, and because the material is of low quality from the manure manufacturer's point of view. On the other hand, Florida has become a great centre of the industry, because mineral of high quality is plentiful and easily mined, and can be readily transported to where it can be shipped all over the world. The production of raw phosphates by the principal producing countries for certain years from 1900 onwards is shown in Table X.

TABLE X.

PRODUCTION OF RAW PHOSPHATES.

(Metric Tons).

	1900	1903	1905	1910	1912	1913
Belgium ...	...	184,120	193,305	202,880	203,100	219,420
France ...	...	475,783	476,720	333,506	330,000	335,000
United States	1,491,216	...	1,964,210	2,724,849	3,231,636	3,202,636
Algiers ...	about 300,000	320,834	334,784	319,079	388,515	461,030
Tunis ...	171,288	352,088	559,645	1,286,262	2,057,498	2,284,678
Egypt ...	none	none	none	2,397	69,958	101,311
Christmas, Ocean and Nauru Islands	...	...	211,052	456,000	459,512	...
All countries	...	2,433,779	3,955,686	5,344,981	6,886,299	6,935,677

The figures from certain countries for 1912 and 1913 are not complete, as much delay takes place in certain cases in issuing statistics, so that the figures for the total production of the world for these years, and especially for 1913, require to be increased somewhat. The table is sufficient, however, to show the very rapid rate at which the world's production of raw phosphates is increasing. The United States, which has been for many years the largest producer of raw phosphates, embarked on this industry just fifty years ago—in 1867. An article by W. G. Phalen of the United States Geological Survey, published in the American Fertiliser Handbook for 1914, gives interesting statistics of the development of the industry from 1867 to 1912. From this publication the figures in Table XI are taken.

TABLE XI.

PHOSPHATE ROCK PRODUCTION IN UNITED STATES OF AMERICA.

From 1867 to 1887 production was 4,442,945 tons.

1888	...	...	448,567 ,,
1890	...	...	510,499 ,,
1895	...	...	1,038,551 ,,
1900	...	...	1,491,216 ,,
1905	...	...	1,947,190 ,,
1910	...	...	2,654,988 ,,
1913	...	...	3,097,021 ,,

The first United States' desposits to be worked were in South Carolina. It was not till 1888 that the Florida deposits began to be mined, but they soon became more important than those of Carolina. In 1896 production began in Tennessee, and this soon became of importance also. Practically all the American phosphates are obtained from these three States, over 80 per cent. of the whole coming from Florida. There are also extensive deposits known to exist in several other States, such as Utah, Idaho, Wyoming and Montana. The Bureau of Soils, U. S. Department of Agriculture, estimates that the reserves of natural phosphates in the United States, calculated as high grade material of 75 per cent. tricalcic phosphate, amounts to 10,677,673,125 tons*, of which over ten thousand million tons exist in the almost untouched deposits of the Western States of Utah, Idaho, Wyoming and Montana. There is no prospect, therefore, of a failure of phosphate supplies in the United States, even if the present consumption increases many times over.

Though the North African deposits do not produce quite so much phosphate as those of the United States, Tunis increased its production in the ten years preceding the war even more rapidly than Florida, and had become during these years the greatest exporter of raw phosphate in the world. While the United States still produce more phosphate than North Africa, the greater part of that production is consumed at home. On the other hand, nearly the whole production of Tunis and Algiers is exported, chiefly to the markets of Europe, of which it now forms the principal source of supply.

With regard to the consumption of phosphates there is much the same tale to tell as with regard to nitrogenous manures. Britain, which at one time occupied a leading position as a consumer of mineral phosphates, has in comparatively recent times been passed by several other countries, and is not increasing her consumption nearly so rapidly as most other civilised countries. This is illustrated by Table XII, which gives the import of raw phosphates for several of the chief consuming countries in 1905, 1910, and 1913, taken from statistics published by the International Institute of Agriculture.

* International Institute of Agriculture, Bulletin of Agricultural Intelligence and Plant Diseases, 1915, p. 326.

TABLE XII.

IMPORTS OF RAW PHOSPHATES.

(Metric Tons.)

	1905.	1910.	1913.
United Kingdom	427,744	462,904	547,666
France ...	446,722	687,673	940,791
Germany ...	501,048	723,271	928,798
Italy ...	240,144	422,714	529,776
Japan ...	88,932	168,231	331,288
Australia ...	15,575	107,300	162,599

The table shows that the import of phosphates by European countries like France, Germany and Italy, as also the import by countries like Japan and Australia, was, before the war, increasing at a far more rapid rate than was the import by the United Kingdom. In addition to her import, France uses at home most of the large amount of raw phosphate produced in the country, and is the largest consumer of mineral phosphate in Europe, though Germany is not far behind. The largest consumer of all countries is the United States, which is increasing her consumption with great rapidity.

Mineral phosphates are used mainly for the manufacture of superphosphate, only small quantities being used directly as manure and for other purposes. The manufacture of superphosphate is, then, the use to which nearly all of the mineral phosphate is put, and it is as superphosphate, or as mixed manures containing superphosphate, that nearly the whole of it is consumed in agriculture. Table XIII., the figures of which are taken from the returns of the International Institute, shows the production of superphosphate in some of the chief producing countries, and tells a similar tale to preceding tables. In France, Germany, and Italy the production has grown with astonishing rapidity, and the same is true of most of the countries which produce smaller quantities, while in Britain the growth of production is only moderate. The case of the United States is the most remarkable of all. Complete figures are not given, but the production in 1904 is stated at 695,068 tons, and in 1909 at 1,089,600 tons.* The production has therefore increased nearly fivefold in ten years, and in 1913 far exceeded that of any other country in the world.

TABLE XIII.

PRODUCTION OF SUPERPHOSPHATE.

(Metric Tons.)

	1900.	1903.	1905.	1910.	1913.
United Kingdom..	621,000	655,200	772,200	756,900	820,000
France ...	945,000	1,053,000	1,314,000	1,634,000	1,920,000
Germany ...	644,400	765,000	873,000	1,353,000	1,818,700
Italy ...	252,000	392,400	480,000	1,050,200	972,500
United States ...	...	...	...	...	3,248,000

The world's production in 1913 is estimated to have exceeded eleven million tons. By far the most important use of sulphuric acid before the war was in the manufacture of superphosphate.

* Production et Consommation des Engrais Chemiques dans le Monde, p. 54.

The greatest rival of superphosphate in recent times has been basic slag. This is a by-product of the purification of steel by the basic process. It began to be produced at Middlesborough by the Thomas-Gilchrist or basic modification of the Bessemer process in 1879, and was for some time a waste product. Its value was soon recognised in Germany, and the slag produced in Britain was for a time entirely exported to Germany. Even up to the outbreak of war much of the slag produced in Britain was exported. The basic process of steel manufacture proved of much greater advantage to the steel industry of Germany, Belgium, and Luxemburg, than to that of the country of its origin, and in a few years Germany was producing far larger quantities of basic slag than the United Kingdom. Also the use of slag in agriculture became popular in Germany very rapidly, and the consumption of slag in that country has always far exceeded that of any other country. Even when its value began to be recognised in Britain the supply of the material remained for years largely in the hands of German firms. It was from the late German firm of H. & E. ALBERT, London, that the following figures showing the world's production of slag up to 1900 were received.

TABLE XIV.

WORLD'S PRODUCTION OF BASIC SLAG.

Year.	Tons.	Year.	Tons.
1880.	10,000	1895.	845,000
1885.	150,000	1900.	1,760,000
1890.	410,000	—	—

The production of slag in Germany, including Luxemburg,* was 4 326 tons in 1880, 358,320 tons in 1890, and 953,370 tons in 1899.

The increase in production in the chief producing countries since 1900 is shown in Table XV., the figures for which are taken from the returns of the International Institute of Agriculture.

TABLE XV.

PRODUCTION OF BASIC SLAG.

(Metric Tons).

	1900.	1905.	1910.	1913.
United Kingdom	123,000	244,500	260,000	404,000
France ...	230,000	338,000	534,000	—
Belgium ...	112,000	225,000	488,000	655,000
Germany (including Luxemburg)	1,035,300	1,551,000	2,007,000	2,500,000

The net export of slag (export less import) is shown for the chief exporting countries in the next table.

TABLE XVI.

NET EXPORT (EXPORT LESS IMPORT) OF BASIC SLAG.

(Metric Tons).

	1905.	1910.	1913.
United Kingdom	—	218,134	115,796
Belgium	213,240	422,644	541,354
Germany	72,142	71,366	272,809

* JOUR. SOCY. CHEM. IND., 1901, XX. 521.

The tables show that Germany consumed nearly the whole of her immense production of slag, while, in spite of her moderate production, up to the outbreak of war, Britain exported a considerable proportion of what she produced. Belgium had by far the greatest net export, but still retained a considerable quantity for home use relatively to her small acreage.

POTASH MANURES.

Until recent times the ashes of plants and the lees of wine formed almost the only sources of potash and its salts. Nitrate of potash or nitre was obtained as an efflorescence from certain soils in India and some other hot countries; but most potash compounds, whether for use as manure or for other purposes, were obtained from wood ash, kelp—the ash of sea-weed, —barilla, and other such sources, or from the tartar or argol of wine. The great German deposits of potash salts began to be developed about 1860, and since then the German potash industry has continually grown and increased until it had before the war almost a monopoly of the world's supply of potash salts for use as manure and for other purposes. The industry was developed with the help of the Prussian Government, which had a direct interest in the mines. All the producing companies were formed into a syndicate, which regulated production and prices, and conducted a thorough, well-organised and scientific propaganda, at first in Germany itself, then in Western Europe and the United States, and latterly throughout the whole world. Probably no branch of the fertiliser industry has been so thoroughly controlled and organised as the potash industry, and in the use made of agricultural science for propaganda purposes it has been the model and example which has been distantly followed in recent times by older branches, such as those which deal with nitrate of soda, sulphate of ammonia, and mineral phosphates.

The older, badly organised potash industries, such as the kelp industry had before the war almost ceased to struggle against this great, well-organised syndicate. Until the United States, owing to a fiscal dispute, began a few years ago to search seriously for home sources of potash compounds, all countries seemed to be content to draw their supplies from the unlimited stores of the organised and efficient German syndicate, and to allow any feeble home potash industry they had to go to the wall. From this lethargy we have recently been roused by the war, and the scarcity and rapid rise in price of potash compounds has caused feverish activity in the search for independent sources of these valuable products.

The German Potash Syndicate has always published very complete statistics of its production and export of potash compounds, and has freely used these throughout the world for propaganda purposes. There was therefore little difficulty in obtaining complete returns of the production and consumption, before the war, of the Syndicate's products in agriculture and industry throughout the world. These statistics, naturally, make no mention of potash compounds derived from other sources, but during the past twenty years, at any rate, production from all other sources was very small in comparison with the German production.

The following table, compiled from statistics published by the Syndicate before the war, shows the rapid and continuous growth of the industry from 1861 onwards :—

TABLE XVII.

GERMAN PRODUCTION OF POTASH COMPOUNDS.

(Metric Tons).

	Crude Salts.	Concentrated Salts.		Crude Salts.	Concentrated Salts.
1861. ...	2,293	—	1890. ...	1,279,265	209,961
1865. ...	89,060	—	1895. ...	1,531,585	212,558
1870. ...	288,598	—	1900. ...	3,037,035	409,582
1875. ...	522,866	—	1905. ...	4,878,598	579,448
1880. ...	668,596	—	1910. ...	8,160,778	1,124,629
1885. ...	929,050	144,850	1913. ...	11,607,510	1,647,906

The crude salts are the raw salts as raised from the mines. These are partly used as fertilisers without further treatment, except grinding and grading, and partly used for the manufacture of such concentrated salts as muriate of potash and sulphate of potash. Under "Crude Salts," in Table XVII. is included the well-known manure kainite. The chief crude salts raised from the mines are carnalite and kainite. Carnalite is used chiefly for the manufacture of the concentrated salt muriate of potash.

The chief concentrated salts produced are muriate of potash and potash manure salts. Sulphate of potash is produced in much smaller, though still large quantities.

The table shows that the expansion has been specially rapid since 1905, both for crude and for concentrated salts. During the eight years, 1905-1913, the production of crude salts has increased at an average rate of over 800,000 tons per annum, and the manufacture of concentrated salts at an average rate of over 130,000 tons per annum. These are remarkable figures, and indicate the possibilities of the potash industry in the future and the importance of developing all independent economic sources of potash salts.

By far the most important use of potash salts is in agriculture. In the earlier days of the industry the German potash salts were used principally in industries other than agriculture, but the Syndicate soon recognised that their greatest field for expansion was in agriculture, and both at home and abroad they have diligently cultivated the agricultural market. The great expansion in the industry shown in Table XVII. has been mainly due to the increase in the agricultural use of potash. This is illustrated in Table XVIII., in which all German potash compounds are reduced to the common terms of pure potash, which gives the best basis of comparison for such a purpose:—

TABLE XVIII.

CONSUMPTION OF POTASH IN AGRICULTURE AND INDUSTRY.

	1880.	1890.	1900.	1910.
	tons	tons	tons	tons
Pure Potash used for Agricultural purposes ...	29,127	71,679	255,722	766,584
Pure Potash used for Industrial purposes ...	39,453	50,623	70,257	91,299
Per cent. used for Agriculture	42·4	58·7	78·4	89·3

In 1880 only 42·4 per cent. of the German production of potash was used for agriculture, while in 1910 almost 90 per cent. of the enormously increased production was used as fertiliser, and the use in all industries other than agriculture was relatively small. Putting it another way, in the thirty years from 1880 to 1910, the consumption of German potash in all industries other than agriculture was a little more than doubled, while the agricultural consumption increased more than twenty-six fold.

Germany is the chief user of her own potash salts, whether for agriculture or otherwise. In Table XIX. some statistics for recent years are given in terms of pure potash.

TABLE XIX.

CONSUMPTION OF POTASH IN GERMANY AND OTHER COUNTRIES.

Stated in Terms of Pure Potash in Metric Tons.

	Agriculture		Industry.	
	Germany	All other countries	Germany	All other countries.
1903	153,630	147,784	39,370	25,636
1906	228,485	241,883	48,731	28,435
1909	305,960	284,067	55,281	32,024
1911	422,341	426,060	57,498	34,028

Germany uses practically as much potash for agricultural purposes as all other countries put together, and uses much more than all other countries for other industries. These figures, which are derived from the statistics of the Potash Syndicate, do not take account of potash produced in other countries than Germany, such as the potash derived from kelp in this country and Japan, and the nitrate of potash produced in India. As already pointed out, however, the production from these sources is small, and would not make a very serious alteration in the figures given in the table. The increase in the consumption has proceeded fairly equally both in Germany and in other countries, whether for agriculture or for other industries, and both in Germany itself and in other countries it is the agricultural market which is the important one.

After Germany, by far the most important consumer of potash salts is the United States, and, before the supply was cut off by the war, the market there was rapidly expanding. Other important consuming countries were the United Kingdom, France, Belgium, Holland, the Scandinavian countries, and Austria-Hungary. In the United Kingdom the consumption increased rapidly between 1900 and 1913. Per acre of arable land Scotland was one of the chief consumers of potash manures before the war, though much Scottish soil stands less in need of special potash manuring than the light potash-hungry soils which form such large areas in Germany itself, and others of the chief potash-using countries.

In spite of the predominance of the German potash industry, the manufacture of potash compounds from seaweed ash or kelp survives to a certain extent in Scotland. It has not been found possible to obtain exact figures of the production of potash salts from kelp, but it probably amounts to two or three thousand tons of concentrated potash salts per annum. This industry could, no doubt, be considerably developed.

OTHER MANURES.

Besides the great classes of Nitrogenous, Phosphatic, and Potassic manures discussed above, there is a very large trade in a number of other fertilisers, several of which are organic waste products from other industries. In addition to the industry in real guano, which is composed of the dung and waste of sea-birds, there is a considerable industry in substances called guano, the chief of which is fish manure or fish guano, made from fish refuse. The net import of guano—import less export—calculated from the returns of the International Institute of Agriculture for the years 1905, 1910, and 1913 for the chief importing countries, is shown in the following table:—

TABLE XX

NET IMPORT (IMPORT LESS EXPORT) OF GUANO, NATURAL AND ARTIFICIAL.

(Metric Tons)

	1905	1910	1913
United Kingdom ...	26,810	15,035	22.590
France ...	5,498	2,079	1,035
Belgium ...	8,735	—10,721	20,095
Germany ...	71,485	40,244	55,792
United States ...	26,063	44,978	19,412

That these imports of guano are largely made up of artificial guanos, such as fish guano, is evident from the following considerations: (1) The total production of natural guano in Peru in 1913 was 74,707 metric tons, of which 37,177 tons were reserved for home consumption, the other 37,530 tons being exported. The production of natural guano elsewhere was about 6,000 tons in South Africa, and 2,100 tons in the New Caledonian islands. The total export of natural guano, therefore, did not exceed 46,000 tons in 1913. The net import shown in Table XX. for the same year was nearly 120,000 tons. (2) In the returns Norway figures as an exporting country, and is not an importer. The only guano exported by Norway is fish guano. The quantity exported by Norway in 1913 was 14,214 tons.

In Table XX. Belgium has a minus import of over 10,000 tons in 1910. This is accounted for by the fact that large quantities of manure, as of other substances, pass through Belgian ports into Germany. In 1910 the Belgian import was below the average, but there were specially large imports in 1909 and 1911.

A class of manures, of which there is not only a very large production and internal trade, but a very large international trade, consists of organic nitrogenous materials of animal and vegetable origin. The chief of these manures of animal origin are prepared from horns, hoofs, wool waste, hair, feathers, blood, skin and leather, while the chief vegetable products are cakes and meals left as by-products after the extraction of oil from certain oil-seeds. Such materials have been used as manure to a certain extent since early times, long before the present great industry in mineral or chemical manures had its origin. Thus we find that Davy, in his 'Elements of Agricultural Chemistry,' published in 1813, not only mentions the use of fish refuse as manure, but also points out that horn, hair, feathers, woollen rags, rape-cake, and malt dust all form valuable manures. He states that Mr. Coke of Holkham, who was so well known in the history of the improvement of

agriculture in the East of England, brought the practice of the use of rape-cake as a manure for turnip crops to "its highest degree of perfection."

At the present day there is still a considerable industry in these articles, some of which are very popular and trusted manures in certain districts. Rape-dust or rape-meal, for instance, is extensively used as a manure in certain parts of England, and in India large quantities of castor-cake and meal are used. In the International Returns of Imports, Germany and France appear as the largest importers of animal refuse materials. Germany is stated to have imported in 1913, 2899 tons of residues of horns and hoofs for manurial use, and 64,421 tons ot "various animal residues"; while France imported in the same year 82,044 tons of "various animal residues."

All these figures, however, are dwarfed by the enormous import by Japan of soya-bean cakes and other oil-cakes for use as manure, which in 1913 amounted to 859,008 tons. Such cakes are the principal concentrated manure used in Japan. We have seen above that in recent times Japan has rapidly increased her consumption of chemical fertilisers—such as sulphate of ammonia and superphosphate—but the traditional imported manure used in that country is bean-cake, which is imported mainly from China. Japan also appears in the returns as having imported, in 1913, 4,820 tons of "various animal residues." The above figures show that the international exchange of oil-cakes for fertilisers is a very large industry in the far East, and must employ a great amount of shipping.

Lime.—Though very large quantities of lime are applied to the soil in different countries, practically it is not an article of international exchange. Though statistics can be obtained in different countries of the production of lime, much of this lime is used for industries other than agriculture, and there is no means of determining how much is used for agriculture and how much for other purposes.

We are safe to say, however, that since 1880 the use of lime for agriculture in Britain has diminished, and in this respect we have not progressed, but have gone seriously backwards.

To sum up the position with regard to manures, the whole of the statistics show that, since 1880, an enormous development has taken place in the world's fertiliser industries, and a great world-wide commerce has sprung up in materials for making fertilisers, and in the finished fertilisers themselves. Fertilisers are now consumed in millions of tons per annum in the chief countries in which intensive agriculture is pursued. The United States, for instance, which is stated * to have consumed in 1880 1,150,000 tons of fertilisers, and to have increased this consumption to 2,200,000 tons in 1900, developed the industry at a greatly increased ratio after that date, and, according to the official census of production, produced 5,096,778 tons in 1909, and 7,633,925 tons in 1914, an increase of nearly 50 per cent. or over two and a half million tons in five years. During this period of development the growth of the British production and consumption of fertilisers has been relatively slow.—Transactions of the Highland and Agricultural Society of Scotland.

* American Fertiliser Handbook, 1914.

COMMERCIAL FIXATION OF ATMOSPHERIC NITROGEN.

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The following Memorandum prepared for the Board of Agriculture, Mauritius, is of general interest :—

In view of the existing difficulties in obtaining supplies of artificial manures from other parts of the world owing to war conditions it is but natural that interest should have been aroused in Mauritius, concerning the possibilities of making good deficiencies from local sources, and in this connection attention specially centres on the question of the production of synthetic Nitrogenous manures from the atmosphere.

Additional weight is lent to possibilities in this direction inasmuch as there are available in Mauritius considerable reserves of unutilised energy in the shape of water power, part of which at any rate might be capable of employment with such an end in view.

As this question is of a considerable permanent interest and is capable of being fraught with results of importance, the following summary of information has been prepared from available literature indicating the present position in relation to the production of synthetic Nitrogenous manures and the possibility of the development of their production in the Colony.

That it is possible to fix Nitrogen from the air by electrical means has long been known, the discovery dating back to the time of Priestley, who showed that under the influence of the electrical discharge, Oxygen and Nitrogen slowly combine to form oxides of Nitrogen which subsequently change by more or less complex chemical processes into Nitric and Nitrous acids or Nitrates and Nitrites ; this discovery was subsequently verified and amplified by Cavendish in 1784. There the matter rested until about 25 years ago when attention first became seriously attracted to the possibility of producing Nitrate on a commercial scale by such means, the first effort being made in Switzerland by Aloys Noville in collaboration with C. E. and P. A. Guye.

Since then, the synthetic production of Nitrogenous compounds from atmospheric Nitrogen has developed enormously, while two other important alternative processes have also been evolved. Figures for the total production of such products are naturally difficult to obtain at the present moment but there seems reason to believe that in the aggregate they may approach 2,000,000 tons per annum, of which it has been stated that 1,000,000 tons alone is being produced by the Badische Anilin and Soda Fabrik in Germany.

There is no doubt that the war has exercised an enormous influence on the development of the manufacture of such products ; at the present time the bulk of the out-turn is being absorbed for the manufacture of explosives, but with the return of peace conditions, it is practically certain that a revolution will be found to have taken place in the production of these substances for manurial purposes., while the fears which were at one time entertained of the consequences of the possible exhaustion of the naturally occurring supplies of Nitrogenous fertilisers will have been banished for ever.

As stated there are three important processes at present being worked on a commercial scale for the production of synthetical Nitrogenous compounds from the atmosphere.

The first of these, termed the Cyanamide process, depends on the fact that under suitable conditions Nitrogen will unite with Calcium Carbide to form Calcium Cyanamide, a product which has been on the market for some years as a fertiliser under the name of Nitrolim. More recently the fact that this compound is capable of decomposition by water vapour to give Calcium Carbonate and Ammonia has been taken advantage of in manufacturing processes, and a considerable proportion of the synthetically prepared Calcium Cyanamide is, it is understood, being converted into Ammonia at the present time in this way.

The second process has during the war attained very considerable application in Germany. It is based on the development of the fact which has long been known that on leading a mixture of Nitrogen and Hydrogen over certain catalysts such, for instance, as iron or Manganese, small traces of Ammonia are produced. The practical operation of the process is due to the work of Hahn who discovered catalysts capable of operating at relatively low temperature, while the subsequent commercial development of his methods was carried out by the Badische Anilin and Soda Fabrik. Essentially the process consists in the preparation of Nitrogen by fractionation from liquid air, and of Hydrogen by the catalytic action of activated iron oxide on a mixture of water gas and steam, the combination of the Nitrogen and Hydrogen under pressure through the influence of a catalytic agent, and the further subsequent oxidation of the Ammonia so produced to Nitric acid again under the influence of a suitable catalyst. This process has already obtained phenomenal development in Germany and is also being practised in England on a limited scale.

The third process is that previously alluded to, namely the direct combination of the Nitrogen and the Oxygen of the air under the influence of the electric discharge to form Oxides of Nitrogen and subsequently Nitric acid. It may be termed the direct process.

Of the three processes the catalytic process has probably attained the widest application, while it is claimed that the efficiency of production per unit of power is in its case more than twice as efficient as the cyanamide process and nearly eight times as efficient as the direct process. Against this, however, must be set the fact that the cyanamide and more especially the catalytic processes require a considerable amount of highly skilled supervision, while the necessary power requires to be supplied in the form of fuel; the direct process is relatively simpler to control, and readily lends itself to the exploitation of cheap natural sources of power, notably water power, which the other processes do not. Moreover, it is highly probable that the efficiency of the direct process can be and will be very greatly increased in course of time, the efficiency depending on the type of electrical furnace employed. Even at the present time the direct process is apparently able to compete successfully with the other two under European conditions when fuel is normally cheap and plentiful and skilled labour can be readily procured, and in the Colonies where water power facilities exist, there would appear to be reasonable expectation that a properly worked and equipped plant for producing Nitrates by the direct process deriving its power from natural

sources, might be able to hold its own against importation from foreign countries, bearing in mind the advantages capable of being derived owing to the cost of transport and other factors.

For the above reason the following condensed account of the direct process as at present operated, so far as can be ascertained, is subjoined:

In its essential form the plant consists of an electric furnace connected to a blowing apparatus which is employed in feeding air to the furnace. The chemical combination of Nitrogen and Oxygen takes place in the arc, Nitric oxide being formed and it is then necessary to cool the product very rapidly to prevent subsequent dissociation of the compounds produced. Subsequently the Nitric oxide formed is oxidised to Nitrogen peroxide and absorbed in water to produce Nitric acid. The oxidation and absorption are performed in a series of towers of special construction.

Finally the Nitric acid produced is neutralised to form Nitrates, the neutralising agent employed depending on the type of product it is desired to turn out.

TYPES OF FURNACE EMPLOYED.

On the type of furnace employed the efficiency of the process largely depends. The principal types employed are as follows :—

1. The Birkeland Eyde Furnace.

This is the oldest and best known type ; it is employed at the Notodden and Saarheim works in Norway. At Notodden there are 32 such furnaces of 600 to 1,000 kilowatts each. The furnace consists of built-up cylindrical steel casings with a disc-shaped chamber in the centre. Air enters by a pipe at the base of the furnace and enters the central chamber by a large number of small holes. Two U-shaped copper electrodes project into the disc chamber from each side, they are adjustable laterally and are cooled by means of an insulated current of cold water. The flame is deflected and made to spread into a circle by means of a special arrangement of electro magnets. In the 1,000 kilowatt furnace the flame is about 6½ feet in diameter. The furnace employs single phase alternating current for the production of the arc and direct current for the electro magnets.

2. The Schonheer Furnace.

This consists of four annular steel tubes arranged vertically. The tubes are arranged concentrically and the innermost which is about 6 in. in diameter forms the reaction chamber ; up the centre of this a standing arc flame is maintained by means of a whirling current of air.

3. The Pauling Furnace.

This presents the special feature that it possesses horn-shaped electrodes having a fan-shaped space between them, while an air blast impinges thereon and fills the fan-shaped space with flame.

4. The Moscicki Furnace.

This possesses the distinctive feature of a water cooled air chamber and works with a single electrode, the lower edge of the reaction chamber functioning as the other electrode at earth potential, the arc being magnetically blown as in the Birkeland Eyde Furnace.

All of these types of furnace work with single phase current.

5. The Kilburn Scott Furnace.

This is designed to work with three phase currents.

The furnace consists essentially of three tabular electrodes separated from one another by columns of fire-brick and enclosed in a chamber in the shape of an inverted cone. The electrodes are of special construction and are water cooled. The arc is air-blown as in the Schonheer and Pauling Furnaces.

A special feature of this furnace lies in the adoption of a boiler as a special cooling device. The boiler, which is of the multubular type, forms the roof of the furnace and effects the rapid cooling of the combined gases while the steam generated can be used as a source of power.

The advantage is claimed for the use of three phase currents that there is less fluctuation in the power of the furnace, and thereby the working efficiency is increased.

In some types of furnaces, notably the Kilburn Scott, it is usual to preheat the reaction mixture in some form of preheater; in the case of the Kilburn Scott furnace the necessary heat is derived from the mixture of combined gases which is made to yield up some of its heat to the uncombined materials. The effectiveness of the operation of the synthesis may be and is often increased by the addition to the air of a surplus of oxygen thereby enabling a larger proportion of the nitrogen of the air to enter into combination. This addition of make-up oxygen is however only possible when the production of synthetic nitric acid is conducted in conjunction with other manufacturing processes yielding free oxygen as a bye-product.

ABSORPTION SYSTEM.

When the air passes through the furnace some of it is converted into nitric oxide. Subsequently the mixture of air and nitric oxide passes to a nest of cooling tubes made of aluminium over which water is flowing, then to the preheater where some of the heat is imparted to the supply to the furnace, then to a circular tower made of steel plates lined with acid-proof bricks.

This tower is very large and serves the purpose of permitting the nitric oxide formed as the result of reaction, to be oxidised to nitrogen peroxide. It then passes to the first of four Acid Absorption Towers, each of which has acid-proof open work filling so as to allow gas and liquid to pass freely through but at the same time to bring them into intimate contact. The gases travel up Tower 1, down Tower 2, up Tower 3, and down Tower 4. Pure water is supplied at the top of Tower 4 and passing down forms with the oxides of nitrogen present, nitric and nitrous acids. The latter becomes subsequently oxidised to nitric acid, and nitric acid of about 5% strength flows out of the bottom of the Tower, this is then transferred to Tower 3, where it meets with stronger gas, then to Tower 2, and finally back to Tower 1 on the principle of contra flow.

The final product runs up to 50 % concentration. After passing Tower 4 the gases may still contain some nitrogen oxides which are absorbed either by sodium carbonate or milk of lime. The movement of gases through the Towers is usually effected by means of fans of aluminium.

If desired the resulting acid product may be concentrated by heating, or over sulphuric acid, and subsequently neutralised to form sodium, or calcium nitrate.

To obtain the best results from a furnace a nice adjustment of conditions is necessary, and there are several factors influencing this, e. g.: (1) Voltage and current on which depends the temperature of the furnace, (2) Pressure and velocity of flow of air through the arc flame, and (3) Amount of preheat of air and effectiveness of coolness. All of these factors require careful and constant watching.

Nerst gives the following percentage, as the theoretical maxim yields for different temperatures :—

Absolute temperature. °C.	Nitric Oxide formed per cent.
1,500	0·1
1,928	0·5

Absolute temperature. °C.	Nitric Oxide formed. per cent.
2,202	1·0
2,403	1·5
2,511	2·0
2,854	3·0
3,103	4·0
3,227	5·0

It is important to note that the percentage efficiency increases rapidly with rise of temperature.

Regarding the yield per kilowatt year HOFER has calculated that the maximum theoretical yield per kilowatt year is 1,850 kilos at a temperature of 3,200°c.

PAULING guarantees for his furnace the production of 60 grams nitric acid per kilowatt hour of electrical energy, or for 8,000 hours a year, 480 kilos.

At the Notodden factory the output per kilowatt year is 850 to 938 kilos of nitrate of lime containing 13 % nitrogen.

The annual production of Notodden is given at 20,000 tons of nitrate of lime, and 4,000 tons of nitrate of ammonia. The production of the Saarhein factory has been given as 70,000 tons of nitrate of lime, and 8,000 tons of sodium nitrate.

Data regarding cost of the plant and the size of the smallest workable commercial unit are not very abundant. It has, however, been authoritatively stated that a practicable commercial unit would be about 1,000 kilowatts having any three furnaces of 330 kilowatts each.

Such a plant it was estimated might be put down in England under normal conditions for about £6 to £7 per kilowatt including all necessary apparatus but not apparently building. Making all allowances for increased cost of erection in Mauritius, such a price is by no means prohibitive, and if anything like the outturn quoted was realised, it would seem that if the necessary power was available such an undertaking might be capable of successfully functioning under Mauritius conditions.

The following data taken from the Mauritius Almanac give the gaugings of the principal waterfalls of the Colony.

Name of River.	Name or description of waterfalls.	Height of waterfall in feet.	Volume in cubic ft. per minute.
River Profonde ...	Near District Board's dam...	14	550
R. Francoise ...	... ...	14	230
G. R. South-East ...	On Midland Estate ...	9	800
	Pave Citron ...	34	800
	Des Hirondelles... ...	28	1,000
	Deschiens	19	1,530
	Diamamoo	63	2,315
	(As available head, 100 feet).	...	1,590
	(Available head probably 50 feet by going a little above the Cascade Beau-Champ..	25	4,000
Le Chaux River ...	Mme. Keen ...	15	150
R. du Poste ...	Near Railway Station ...	56	175
Bain des Negresses..	Near Gris-Gris ...	35	150
Savane River ...	C. Cecile ...	105	580
Do. ...	Below Terracine dam. ...	77	250
R. des Galets ...	C. Pigeons ...	22	190
R. du Cap ...	Chamarel ...	320	330
R. Profonde ...	Near Martindale Bridge ...	17	225

FARMYARD AND OTHER MANURES.

In an article under this heading, The Field of September 15, 1917, draws attention to a possible divergence of opinion between farmers and their scientific observers concerning the relative merits of farmyard and artificial manures; in this it states: 'There are two points upon which it looks as if practice and science were to come into conflict. The latter has a greater belief in the virtues of the concentrated artificial manures than the former. The farmer appreciates the qualities of artificials, but in his estimation, based upon personal experience and careful observation, they can be used to better advantage to supplement dung than to displace it. It will take a great deal to shake this conviction, for it is rooted in generations of careful study and practical achievement. The modern manufactures, and natural materials of commerce have a very important province to fulfil, but there is proof both here and on the Continent, particularly in Germany, to show that continuous exclusive artificial manuring is detrimental to the health and ultimate productivity of the soil. This may be due to chemical action, but it is quite as likely to result from the absence of the beneficent influence of farmyard manure upon the physical state of the land. It is known that while concentrated fertilizers may, in certain circumstances, be more effective than dung in forcing crops safely through critical stages of development, and, used freely, will produce more vigorous growth than farmyard manure alone, the latter acts as a valuable corrective to weather extremes; it conserves moisture in dry seasons, and facilitates drainage when there is an excess of water in the surface soil. The confidence reposed in manure made in the yards, therefore, is firmly founded upon solid economic teaching coupled with practical attainments. . . . . Dressings of artificial manures may be added with varying advantage, often very great benefit, but animal manure should, wherever practicable, form the foundation in the general scheme of manuring land."

As regards West Indian agriculture and the advice given by scientific advisers to planters, we think it may safely be asserted that this is mainly in accord with the view of the writer of the article quoted above. Here both scientist and planter realize the value, indeed the necessity, of using farmyard manure or its equivalent, though the advisers of the planters may at times urge that more farmyard manure should be used, that more effort should be made to increase the quantity that is available, and that greater pains should be taken to conserve it so as to avoid waste of its valuable qualities.

As The Field's article indicates, farmyard manure performs two distinct functions: it provides material which acts, more or less directly, as food for the crop, and it exerts certain beneficial effects upon the soil. The former of these functions can be fulfilled to a very large extent by artificial manures, but the function of soil amelioration is largely confined to farmyard manure, or to the somewhat similar substances employed by way of 'green dressings.' The provision of decaying vegetable matter, to form what is familiarly spoken of as humus, is recognized to be essential to the production of fertile fields, and it is also acknowledged that this provision is even more necessary in the tropics than in temperate regions, on account of the rapidity with which humus decays and disappears under tropical conditions of heat and moisture.

At the present moment the difficulty of the West Indian planter lies in the fact that he is unable to obtain those quantities of artificial manures which practice has informed him to be desirable for supplementing the farmyard manure commonly used.

It is quite true that the employment of artificial manures is often regarded both in England and in the colonies as evidence of scientific agriculture, and so it is to a certain extent; it may be true also, that the undue or wasteful use of these manures often characterizes the less skilful planter, whose practical experience may not have kept pace with his theoretical ideas, but it cannot be said that scientific workers who have had much experience in the tropics underrate the value of farmyard manure, or advise planters to neglect its use in favour of artificials.

'The other point,' says The Field, 'upon which a division of opinion is probable is the influence of the ration upon the fertilizing value of the dung. Science appears to be changing its view in respect to this question. It has been suggested that existing beliefs concerning the fertilizing properties of manure made from stock fed liberally with meals and cake are not justified by actual results. The evidence upon which this far-reaching pronouncement is based has not yet been made known, but should this plea be seriously advanced, a sharp conflict with practical experience is assured. Farmers, who had the support of early scientists and many still living, hold decided views on the value of high feeding as a source of soil fertility, and, as a matter of fact, the whole system of farming is based upon the acceptance of this principle. There are not a few who believe that the present estimate is founded upon too generous a scale, but science will tackle a difficult problem if it should now set out to disprove what its earlier exponents and successive generations of competent farmers established as a fundamental condition in good husbandry.'

This question receives much less consideration in the West Indies than it does in Britain; it is perhaps a pity that it does so, for a fuller perception of the points at issue would lead to more careful conservation of the farmyard manure produced upon estates.

There is one point in connexion with the use of farmyard manure which may perhaps be worth raising at this point, and that is, the value of farmyard manure as a means whereby certain necessary beneficial bacteria are conveyed to the soil. It is probable that the beneficial effect of farmyard manure is largely influenced by the manner and the rate at which it undergoes change in the soil. The changes are, doubtless, largely caused by certain bacteria which have the property of decomposing the cellulose of the tissues of the vegetable matter existing in the manure. The necessary bacteria exist in the alimentary tract of the animals producing the manure, and continue their functions in the manure heap and in the field. In this way they help to render more immediately useful the tissues contained in the litter which forms a large part of most farmyard manure and the vegetable matter from other sources which is added to the soil. In this connexion the suggestion has been made that probably the addition of small quantities of farmyard manure, with its attendant bacteria, to the soil at the same time that green dressings are applied, will prove useful, the idea being that, in the event of there being a deficiency of these organisms in the soil, the green dressing will only become available at a slow rate, and so may fail in its efficiency, whereas the addition of the required bacteria may speed the process of decay, and so hasten and increase the activity of the green dressing.

It is probably on account of this bacterial action that planters prefer, when possible, to put the extra material in the way of bush, grass, and the like, into the pens to mingle with the farmyard manure, rather than to bury it directly in the land. It would be a useful matter for experiment, to determine whether similar useful action will go on in the field if additions of farmyard manure are added to green dressings. If this is the case, it may possibly lead to an increased use of the practice of green dressing, which appears to be suffering some neglect.—Agric. News, Barbados, Vol. XVII, No. 412.

CO-OPERATION.

CO-OPERATIVE CREDIT SOCIETIES IN MAURITIUS.

There have been no additions to the number of Societies in operation during the past year ; the total number of Societies operating has been 23 comprising 2,823 shareholders. The liquidation of the Phoenix-Vacoas Society has not yet been entirely completed, there appears however to be reason to believe that the settlement will shortly be forthcoming.

A close control has continued to be kept over the operation of the Societies. The books of all Societies were inspected by Mr. F. Birkinshaw in January 1917, and by Mr. Shand Harvey in March and June of the same year. It is found that it is still necessary to exercise a very careful supervision of accounts in the case of many of the Societies ; the system of book-keeping in force is by no means simple and in the case of the less intelligent Secretaries entries of items under wrong sub-heads are not infrequent. The general principles involved, however, appear to be fully grasped by the members of the various societies and it is satisfactory to be able to record that when wrong records were made the errors were always readily recognisable.

The work of the managing committees has continued to be supervised by the Inspector and advice and assistance freely given on all points. In addition to visits to individual societies, the plan has been adopted by the Inspector of setting aside one morning a week for attendance at the Town office of the Department of Agriculture, to afford an opportunity for officers and members of the various societies consulting him on any special points which may arise. This system has been productive of good results and the officers of the various societies have freely availed themselves of the facilities thus afforded.

The principal loans have been issued for purposes of cultivation while in special cases loans have been also issued for such objects as weddings and funerals ; some cases of advances for the purchase of land have been recorded, but in view of the high values for cane land at present in Mauritius every effort has been made to discourage advances for such purposes, except when the purchase price proposed to be paid was such as to allow of the land being profitably worked under more normal conditions.

The necessity for prompt repayment of loans has been emphasised to all societies, and it is gratifying to be able to record that although the total of loans is very considerably larger than on any previous occasion, the outstanding debts show an appreciable decrease over the total recorded in 1916. On June 30th, 1917 four societies showed a total of outstanding debts exceeding Rs. 1,000. The total outstanding debts would show a considerable further diminution had it not been for the fact that in the case of one Society a Factory which received the canes of members had not on June 30th, 1917, completed settlement of the cane transactions of the previous crop. It need

hardly be pointed out that such a condition of affairs operates very hardly on the working of Societies, and offers an unfortunate precedent in relation to the principles of prompt settlement which it is the aim of the responsible officers to inculcate into Society members.

In some few instances it has been observed that members of the managing committees of Societies are in arrears with the repayment of loans which they have received; such a state of affairs constitutes a very bad example for the bulk of the members of the Societies and the question is under consideration of making additional provision in the bye-laws of the Societies to the effect that any member of a managing committee who is in arrear with the repayment of loans should ipso facto cease to be a member of the committee, unless good and sufficient reason for the non-operation of this provision can be shown to exist to the satisfaction of the Registrar in any particular case.

The tendency is also witnessed in some cases to grant disproportionately large loans to members of managing committees. While it is of course essential that the committee should endeavour to ensure issues of loans to persons who will employ the money to the best advantage and are fully capable of repayment, too great a tendency in this direction is to be deprecated as it may involve an unfair distribution, in the shape of loans, of available funds, for it should be a guiding principle of such undertakings that so far as possible equal facilities should be afforded to all members to take advantage of the financial assistance which their Society is in a position to offer.

SOURCES OF CAPITAL.

The capital of the Societies is made up of (1) Share capital, (2) Loans and Deposits from members, (3) Loans and Deposits from non-members, (4) Loans from Government, (5) Money standing to the credit of the Reserve Fund. The present position is shown below :—

Year.	No. of Societies.	Share Capital.	Deposits of Members.	Deposits of Non-Members.	Government Loan.	Reserve Fund.
		Rs.	Rs.	Rs.	Rs.	Rs.
1914	15	52,721	6,067	23,302	37,550	2,312
1915	20	87,028	37,220	22.662	35,550	6,898
1916	23	106,143	41,707	20,814	41,180	15,037
1917	23	116,307	33,440	41,202	40,675	27,948

While there have been no additions to the number of Societies operating and the number of members is approximately the same as last year, the increase in share capital points to steadily increasing popularity and appreciation of the movement. The total number of members was on June 30th, 1917; 2,823, this being 14 less than on the same date of the previous year, while the total share capital on June 30th, 1917 was Rs. 116,307, an increase of over Rs. 10,000 on the previous year.

The total amount of Government loans due by the Societies to Government was on June 30th, 1917 Rs. 40,675. During the year a number of Societies have commenced the repayment of the loans which they received from the Government at the time of their inauguration, on the terms agreed; in this way Rs. 3,505 have been repaid during the year under review; during the same time interest on Government loans has been paid amounting to Rs. 1,185. Two Societies received a loan of Rs. 1,500 each from Government during the year.

An outstanding feature of the year's work lies in the marked increase in the deposits of non-members carrying interest which have been placed with the Societies. The amount of outside capital which Societies are able to attract to themselves in this way can be regarded as an almost unfailing

indication of their condition, and of the confidence which they hold in public regard. When it is borne in mind that during the year specially favourable inducements have been held out for the embarkation of surplus capital in other directions, the results must be regarded as distinctly satisfactory. The majority of the Societies are desirous of attracting further additional capital from outside sources, and it has been carefully explained to them that their capacity for so doing depends very largely on the manner in which they are operated. The financing of loans to Co-operative Credit Societies is now undertaken as a regular line of business by banks and mercantile concerns in India, and the progress made by the Societies in Mauritius warrants the belief that with the lapse of time their credit may become sufficiently established to enable them to attract capital in similar fashion.

RESERVE FUNDS.

In accordance with the terms of the previous report no dividends will be declared by any Society until the expiration of five years from their inauguration, and all profits earned have been credited to the reserve funds accordingly. The principle adopted in relation to the reserve funds is to treat these as fluid resources and to utilise them as part of the working capital of the Societies. It will be seen that the sum of money to the credit of the reserve funds is steadily increasing and the adoption of the policy in question will by the time the allotted period is fulfilled provide an adequate guarantee against the effects of unforeseen or unavoidable losses which may occur in the future.

ANNUAL MEETINGS AND INSPECTION.

The annual general meetings of all Societies were held during the month of July 1917 and were attended by the Registrar and Inspector, the former presiding in each case.

In holding these meetings the plan of procedure adopted followed closely that laid down on the previous occasion by the late Registrar. The meetings were held in the afternoon to facilitate the attendance of members and on all occasions the bulk of the shareholders were present. The meetings occupied a total of 70 hours, ranging in individual cases from 2 to 6 hours according to the size of the Societies.

At each meeting, the records and books of the Societies were inspected and the accounts audited. The pass books of members present were checked with the ledger accounts and pronotes, the balance sheets and summaries of receipts and disbursements were prepared ; the general working conditions of Societies were enquired into ; and office-bearers elected for the ensuing year.

As a result it was found possible to obtain a clear insight into the working of each Society and it is satisfactory to be able to record that on the whole the conditions of the Societies indicate that they are operating along sound and safe lines.

GENERAL.

The association of the work of the supervision of Societies with the Agricultural Department appears to be giving rise to satisfactory results, and is justifying the view put forward by MR. WILBERFORCE, in his report on the prospects of co-operative credit banks in Mauritius dated July 2nd, 1913. The combination of the office of Agricultural Instructor with that of Inspector of Co-operative Credit Societies must be regarded as very suitable and is bringing the work of the Agricultural Department into close touch with the small planters and begetting in them a spirit of confidence which is essential for successful progress in such connections.—REPT. ON THE WORKING OF CO-OPERATIVE CREDIT SOCIETIES IN MAURITIUS FOR THE YEAR ENDING 30TH JUNE, 1917.

PROGRESS OF CO-OPERATIVE SOCIETIES IN CENTRAL PROVINCES AND BERAR.

The annual report of the Registrar of Co-operative Societies of Central Provinces and Berar on the working of Societies for the year 1916-17 indicates that the co-operative movement has maintained the same steady progress as in the past in spite of the difficulties of the agricultural season and the uncertain condition of the money market. The Chief Commissioner in his remarks on the report observes with satisfaction that the stability of the co-operative credit movement in the Province was put to the test and that the system stood it well. There had been a large increase in the amount of loans taken by individuals exceeding last year's figures by over 50 per cent and the repayments have also been very satisfactory. The societies, thanks to the policy adopted by the late Registrar, have increased the owned capital by a very satisfactory sum.

Societies.—The number of societies have increased to 3,627 from 2,685 last year. This is an increase of 942. Of these one is Provincial Bank, 31 Central Banks, 3,267 are agricultural credit societies, 23 agricultural seeds union, 82 are non-agricultural credit societies with unlimited liabiiity. The latter are classified as follows:—52 weavers' societies, 5 dyers' societies, 2 workers in gold and silver, 7 basket makers', 4 workers in brass and copper, 2 potters, 9 petty traders' and 1 a leather workers' society. In addition to these there are a number of societies confined to employees of various Government institutions such as Government Printing Press, Agricultural Office Clerks', Comptroller's Office Clerks', Post and Telegraph, etc. All these have progressed well during the year under review. Two Central Banks, 12 agricultural unions, 881 primary societies have been registered during the year. Out of 1,144 applications received during the period 977 have been accepted, 127 have been rejected, 40 were under consideration, and registration of 35 societies have been cancelled.

Members.—The membership has risen to 95,633 from 60,538. This shows an increase of 35,095 members against last year.

Working Capital.—The working capital of all the societies at the end of the year under review has been Rs. 12,733,824. The working capital at the close of the previous year was Rs. 8,709,187. The increase for the year of Rs. 4,024,637 shows a considerable progress over last year.

Reserve Fund.—The Reserve Fund of all banks and societies amounted on 30 June 1917 to Rs. 514,975 against Rs 377,647 at the close of the previous year thus showing an increase of Rs. 137,328. The Reserve Fund represents about 11½ per cent. of the loans due by members of the primary borrowing societies.

The co-operative societies in the Province have risen to the occasion and have contributed a very satisfactory sum towards the War Loan. The Provincial Bank itself has purchased Rs. 216,900 of the loan and members of societies have invested over Rs. 24¼ lakhs in the loan. The individual number of members thus invested the money has exceeded 18.000.

A characteristic feature of the co-operative movement in the Province is the encouragement of the formation of seed unions under the Co-operative Act. These unions have been in a great measure responsible in the raising and the distribution of pure cotton, wheat and rice seeds to members of co-operative societies. These societies are worked under the guidance of the Director of Agriculture and have thus helped the raising of a pure type of seed for sowing purposes. These unions first began their operations with the raising of pure cotton seeds and their activities are gradually being extended to other directions. There are now unions for raising cotton, wheat and rice seeds.

Another type of unions has been inaugurated in another part of the Province. This consists of groups of co-operative societies borrowing money

from the Central Bank for the purchase of pure seed. The seed thus obtained is sown by members and at the end of the year they return to the society the grain advanced together with 25 per cent. as interest in kind. This 25 per cent. is utilized in paying interest on the loans of the Central Bank, the union expenses and providing a Reserve Fund. At the end of the year under review there have been 5 such unions. Each union is having a store in which grain is deposited. The five unions comprised of 34 societies. They have an area of 1,345 acres under selected wheat and 1,175 maunds of pure wheat seed have been distributed among these Unions.

The unions concerned with the raising of pure cotton seed have produced 346,594 lb. and the Rice Seed Union has produced this year 38,700 lb.

CO-OPERATIVE SOCIETIES IN THE UNITED PROVINCES OF AGRA AND OUDH.

The annual report of the Registrar of Co-operative Societies of the United Provinces of Agra and Oudh on the working of societies for the year 1916-17 is full of interesting reading matter and indicates the good work done in the Province during the last year in spite of the existence of adverse conditions such as the entry of the State as a formidable competitor in the loan market and the high price of money.

The general progress of the movement is shown by the following figures:—

Societies. At the beginning of the year there were 3,189 and at the end of the year the number was 3,245 an increase of 56. These are classified into 58 Central societies, 3,008 agricultural primary societies and 179 non agricultural primary societies. The only increase is shown in the number of Agricultural primary societies and under non-agricultural primary societies a decrease of 3 is shown. But the actual number of new societies was 122 and this number was reduced to 59 by a large number of societies having had to be liquidated within the year.

Members. There is also a reduction of members. Last year there were 118,864 members and at the end of the year under review the number of members was 114,165. The registrar states that the decrease in number of members is partly owing to the fact that the liquidated societies had much larger membership than the new societies which succeeded them and to the weeding of undesirables. There is no reduction of membership in non-agricultural primary societies although the number of societies was decreased by 3.

Capital. The working capital of societies shows a slight increase. At the end of the year there were Rs. 12,040,886 against Rs, 12,034,851 at the end of last year, an increase of Rs. 6,035. The average capital per member has also risen from Rs. 48·2 to Rs. 50·2.

Reserve Funds. The total reserve of the Central Societies has risen from 4·81 lakhs to 5·51 lakhs. The total of that of the primary societies is 6·36 lakhs against 4·69 lakhs last year. The net profit of these societies during the year was Rs. 1·71 lakhs. Non-agricultural primary societies have accumulated reserve of Rs. 50,000 and have made Rs. 19,400 in profit. The reserve of all classes of societies excluding the present year's allowance had at the end of the year risen to Rs. 12·37 lakhs from Rs. 9·91 lakhs last year. The margin of safety is steadily growing and is already substantial.

Resources. The resources of the primary societies are as follows:— Loans from Central Societies Rs. 3,517,000, Loans from non-members Rs. 144,000, loans from Government Rs. 9,000, Shares and deposits of members Rs. 1,271,000, Profits and Reserve Fund Rs. 877,000.

Loans from Government. The loan due to the Government by Central Societies now stand at Rs. 28,907 including *taqavi*. Last year it was Rs. 34,616.

N. W.

GENERAL.

THE EFFECT OF ONE PLANT ON ANOTHER.*

SPENCER PICKERING.

This paper will be read with interest in India in view of the very early attention which was called to the same phenomenon by the late Mr. F. FLETCHER, Deputy Director of Agriculture, Bombay, in MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA, BOTANICAL SERIES, Vol. II., No. 3, 1908.—(EDITOR).

Fig. 3 shows a pot with two mustard plants growing in earth, on the surface of which rested a perforated tray with five inches of earth in it; through this all the water given to the plants percolated. The tray has been

FIG 1. FIG 2. FIG 3.

removed so as to be more clearly visible in the photograph. The presence of such a tray makes practically no difference in the behaviour of the plants in the pot below. Figs. 1 and 2 show a like arrangement, but with a crop of mustard growing in the trays: in one case (Fig. 1) the effect has been to

* Reprinted from the ANNALS OF BOTANY, Vol. XXXI, No. CXXII.

In Fig. 2 there appears to be only one plant; this is due to a fault in the photograph.

reduce the plants in the pot to one-hundredth of their normal size; in the other (Fig. 2) there has been no effect.

The only difference in the two cases is that in Fig. 1 the washings from the surface growth were allowed to reach the plants in the pot (though the penetration of any roots through the perforations of the trays was prevented by a layer of very fine metal gauze at the bottoms of the trays), whilst, in the other (Fig. 2), no washings passed, the holes in the trays having been blocked, and such water as the plants required was given to them direct. The conclusion is obvious; the leachings from the plants growing in the trays must contain something which is toxic to other plant-growth.

Such a very simple experiment must definitely settle the question of toxin production, and should have been made long ago,[2] but as a matter of fact it comes only as the (at present) final step in a series which originated in 1895 in observations on the effect of grass on fruit-trees. As so often happens, we start with the more complex problems, and only gradually work down to the simpler ones.

It has now been established with a reasonable amount of certainty that the deleterious effect of one growing plant on another is a general phenomenon. By means chiefly of pot experiments such as those indicated above, the following plants have been found susceptible to such influence: apples, pears, plums, cherries, six kinds of forest trees, mustard, tobacco, tomatos, barley, clover, and two varieties of grasses, whilst the plants exercising this baleful influence have been apple seedlings, mustard, tobacco, tomatos, two varieties of clover, and sixteen varieties of grasses. In no case have negative results been obtained. The extent of the effect varies very greatly; in pot experiments the maximum reduction in growth of the plants affected has been 97 per cent., the minimum 6 per cent., whilst in field experiments with trees the effect may vary from a small quantity up to that sufficient to cause the death of the tree. The average effect in pot experiments may be roughly placed at a reduction of one-half to two-thirds of the normal growth of the plant, but no sufficient evidence has yet been obtained to justify the conclusion that any particular surface crop is more toxic than another; that such differences exist is highly probable, but all the variations observed so far may be explained by the greater or lesser vigour of the plants in the particular experiments in question. Similarly as regards the effect of grass on fruit trees, though the extent of it varies very greatly, and in many soils is certainly small, we must hesitate to attribute this to any specific properties of the soils in question; for when soils from different localities (including those from places where the grass effect is small) have been examined in pot experiments, they have all given very similar results; and this applies equally to cases where pure sand, with the addition of artificial nutrients, has been taken as the medium of growth.

In searching for an explanation of the effect of grass on trees, various possibilities suggested themselves, and these were excluded one by one, till the only possibility left was that of the formation of some deleterious substance by the growing grass. It would be impossible in this short

2. The details of this, and many of the experiments alluded to below, have not yet been published; a description of the other work on the subject will be found in the Third, Thirteenth and Fourteenth Reports of the Woburn Experimental Fruit Farm, 1903, 1911 and 1914.

communication to give an account of all the suggestions which were negatived, but these included the robbing of the tree of necessary moisture and food by the grass, alterations in the temperature, alkalinity or physical conditions of the soil, and alterations in its carbon dioxide and bacterial contents, the exclusion of all which suggestions is embraced in experiments such as those mentioned above, where the grass or other crop is grown in a separate vessel, merely resting on the surface of the ground, without any possibility of it extracting anything from the soil in which the plant affected is growing.

From the outset the behaviour of trees in grassed land suggested the action of some toxin; not only is the growth arrested, but a peculiar attention in the colouring of the bark, leaves, and fruit occurs, unlike that attending other forms of illtreatment; indeed, the high colour developed by fruit under grass is, in some cases, so great, that expert fruit-growers have been unable to correctly name the varieties after being affected, and if this action of grass could be limited, and suitably adjusted to every tree, it would prove beneficial from the point of view of the fruit-grower, if not from that of the tree itself, especially as a limited check to the growth of a tree generally results in heavy cropping. The extent of the grass action which brings about these notable colour changes is very small, for they are apparent in cases of trees weighing about two hundredweight when only three to six ounces of their roots extended into grassed ground. Such an effect is in itself strongly suggestive of toxic action.

To some agricultural chemists the mention of a toxin as being formed in the soil by a growing plant is as a red-rag to a bull, chiefly perhaps, because it conjures up the picture of the plant ejecting some virulent poison; but though the excretion of toxin from the roots is possible, there is no need for imagining such an occurrence; all plants in growing leave much root-detritus in the soil, and such disjecta may account for toxic properties, just as well as ejecta. That some forms of organic matter may be highly poisonous to plant-life has been established; soil which has been heated to 125° is very toxic, and there is evidence that toxicity may be produced in it by heating to much lower temperatures. (Journ. of Agric. Science, iii., 277). In the case of heated soils, the chemical changes are complicated by changes in bacterial characters; this may or may not be the case with soil which is growing crops; but there is one feature in common between the two, namely that in both cases the toxin is easily oxidized, and that after oxidization, it acts as a plant nutrient, increasing the fertility of the soil. When in pot experiments such as those mentioned, the leachings from the crop in the trays are kept exposed to the air for about twenty-four hours before being given to the plant, their toxic property is found to have entirely disappeared, and in some cases, indeed, they act beneficially; even a two-inch layer of pumice-stone interposed between the tray and the earth in the pot will admit of sufficient oxidation for a reduction in the toxic effect to be discernible.

A reversal of the effect of grass may also be recognised in field experiments, for in a case where apple-trees were planted and kept clear from grass to a distance of 3 feet from the stems, the trees flourished better at first than those without any grass near them (and, of course, much better than those which had been entirely grassed.) But as they grew and their roots

approached the grassed ground, the toxin affected them before it had time to become oxdized, and they began to suffer. Though there are other reasons why land under grass gradually becomes more fertile, the accumulation of the oxidized products of the toxin must constitute an important factor in this enrichment. In certain experiments with apple-trees it was found that soil which had been under grass for ten years induced double as much growth as similar soil which had been under tillage, though when the turf was replaced on the soil, the trees showed all the bad effects of grass,

From the general character of the action of one crop on another, it follows that the tables may be turned on the grass, and, even in pot experiments, it has been proved that grass in the pots will be adversely affected by apple seedlings in the trays. In practice, of course, it is known that grass and other surface crops are adversely affected by trees. This is generally attributed to the shading effect, and to the robbing of the soil of its nourishment. Doubtless the shading produces bad results in many cases, but it may be questioned whether any serious robbing of the soil occurs for there is good evidence for believing that ground under trees, even when worked regularly for timber, increases in fertility, just as does ground under grass. At any rate, it has been found that a surface crop may suffer from trees above it, even in cases where there certainly has been an increase in fertility, and where, also, the shading effect is inoperative so that the damage to the crop can only be attributed to the toxic action of the trees. Thus, a quarter of an acre of land, over which some fifteen apple trees, twenty years of age, were distributed, was planted uniformly with Brussel's sprouts : those under the trees suffered to the extent of 40 per cent. in their growth ; but there were patches in the ground where trees had been growing until the preceding winter, when they had been cut down, leaving the roots undisturbed in the soil, and in these patches the sprouts did better than elsewhere to the extent of 12 per cent. In other parts of the ground canvas screens had been erected, at a height of 6 feet above the surface, to stimulate, and even exaggerate, the shading of the trees, and under these the sprouts gave exactly the same values as on the unshaded ground. Thus the trees themselves materially injured the crop, though the soil under the trees was more fertile than elsewhere, and though the shading was inoperative.

Though differences in the toxicity and in the susceptibility of different plants may be overshadowed by differences due to other causes, it is highly probable, as has already been mentioned, that such differences do exist. The only case of differences of a positive character noticed at present in our experiments, is that the effect of a plant on plants of its own kind is generally greater than that on plants of another kind. This may be fallacious ; but certainly, a plant affects its own kind just as much as any other kind ; and hence we must conclude that the toxin formed by any individual plant will affect that individual itself. This has been proved by growing plants in pots divided into compartments, so that there was no root interference, and comparing these with other plants grown in similar pots not so divided ; in the former case each plant will be affected only by the toxin, and partially by that of its neighbour, but the amount per plant must be the same in both cases, and, as a matter of fact, the plants all gave the same results, except for a slight advantage in favour of those undivided pots, due to conditions which can be easily specified.

"When a stronger and weaker plant, or an older and younger one, are growing side by side, we find that the latter rarely picks up, and generally gets more and more behind its stronger brother. This cannot be due to the stronger one monopolizing the food-supply; for if it exhausted this supply both plants would supply at the same time, and, till that supply is exhausted, both would flourish equally. The inadequacy of any such explanation is demonstrated by taking a pot of soil capable of growing, say, six plants, sowing the seed for three of them first, and that for the other three a certain number of days later. In the case of mustard, when the difference of date is only four days, it is found that, at the end of growth, some two or three months later, the last sown plants are 60 to 70 per cent. smaller than the others. It is evident that three four-day-old seedlings could not have exhausted the nourishment in 7½ kilos of rich soil so far as to leave insufficient food for three other seedlings; nor can a difference in age of four days in a total life of several months account for such a difference in the weights of the plants. But the results become clear if we take into account the toxic effect of one plant on the other, for the later planted the individuals have to start growth under toxic conditions which were absent in the case of those first planted, and throughout their existence their inferiority in size will make them suffer more than their stronger brethren, though the actual amount of toxin in the soil is the same for all. Yet it is found that they are not altogether without their revenge, for the toxin formed by them affects to a certain extent the older plants, and this effect may be traced, even when the feebler plants are only about one-tenth the size of stronger ones. The importance in practice of having seed which will germinate uniformly at the same time, or in having plants of uniform growth in a bed, is demonstrated by these experiments; for a difference of only four days in the germination of one-half of the seeds in the case of mustard reduces the total weight of the whole crop eventually obtained by as much as 20 per cent.

The divided pots have been utilized to ascertain what the effect of crowding in a plantation is when there is no root-interference. In appearance the results were remarkable for with mustard and tobacco plants at distances of 4, 6, and 9 inches apart, the plants were considerably smaller as the distances between them were greater, the deficiency in their height extending up to 30 and even 50 per cent., and they appeared to be in every way inferior. But these appearances were entirely misleading, for it was found that the weights of the plants were the same at whatever distance they were planted and at whatever age they were lifted; moreover, this equality held good throughout the plantation, even including the outer-most rows: thus, interference of the above-ground portions of plants does not affect the amount of growth, but only the quality of that growth.

The results are very different, however, when there is root-interference, as when a number of plants are grown together in one pot, or in one plot in the field; and when the crowding attains to a certain magnitude, the limiting factor is the amount of soil available for each plant: the result of which is that the weights of the plants are inversely proportional to the bulk of soil available (which with soil of uniform depth is synonymous with the area), or, in other words, that total plant-growth is the same, whatever be the number of plants. Thus, in pits containing 7½ kilos of rich soil the total crop was the same with from sixty-four down to sixteen mustard plants (the

latter number representing plants at a distance of 1·8 inches apart), or with sixteen down almost to one plant of tobacco; whilst in unmanured ground in the field, the quality holds good within a wider range, even to plantations with more than 6 inches between the plants in the case of mustard. At the same time also, the outside rows of plants are very much superior to the inner plants.

This latter superiority is one which is continually noticed in field experiments, though the reverse, judging by mere appearances, sometimes obtains. Whether, when the outside plants appear the worse, they are so in reality, may be doubted; at any rate, in all the cases which have been investigated by weighing, it is a superiority which has existed. But appearances would never had led to a correct estimate of the magnitude of this superiority, for these outside plants are often 100 to 200 per cent. greater in weight than the inside ones. The row next to the outside one generally shows some superiority, but the effect of an external position extends to only about 6 inches from the edge of the plot.

The extra vigour of the outside plants is generally attributed to the extra manure which they have to draw upon; but another factor must now be reckoned with, in the extra facility offered for the oxidation of the toxin at the edge of the plot; and this appears to be an important factor. The question is being investigated on three lines; manure beyond a certain limit does not benefit, and even injures a plant; if, therefore, in a plot where the manure has already attained such a limit, we still find that the outside plants show a superiority, this cannot be due to any further surplus of manure. Such a superiority, we find, still exists in ground manured with 100 tons of dung to the acre, and the superiority is little less, if less at all, than in unmanured ground. But these experiments require repetition and extension before definite conclusions can be drawn from them.—Agricultural Journal of India, Vol. XIII, Part I, January, 1918.

MARGARINE INDUSTRY.

PROGRESS AND DEVELOPMENT.

Much of the popular prejudice hitherto prevailing against margarine has rapidly broken down under the stress of war time. Knowledge, also, of the conditions under which it is made and of the material used in its manufacture will help to dispel any prejudice against it. These conditions practically exclude the possibility of bacterial infection, which cannot always be said of butter manufacture.

It is an interesting fact that the production of new foods has often been due to a great war. For instance, the great nutritive value of soya beans (grown in immense quantities in Manchuria) was first brought into prominent notice during the Russo-Japanese war, at least so far as Europeans are concerned. Margarine owed its inception to the Franco-Prussian war. The French Government of that time offered a prize to stimulate the invention and production of a suitable butter substitute, and as a result of this M. Mege Mouries discovered a process for the manufacture of margarine and succeeded in obtaining a product very similar in every respect to butter. The fat used was chiefly beef fat with which about 10 per cent. of cow's milk was churned

up. At that time it was permissible to add up to about 50 per cent. of butter on the Continent, but in England it is not legal to add more than 10 per cent. of butter fat.

Butter fat is a very complex mixture of what are called glycerides (compounds of glycerine and fatty acids). These glycerides are present in varying amounts in other fats and fatty oils; but not all of them are present in any one fat or oil; so the problem which confronts the margarine manufacturer is the blending of these fats or oils in such a way as to produce a substance of the same chemical composition as butter fat. Chemically this could be done by separating pure glycerides from the various fats (making them artificially, if necessry), and then blending them together in the exact proportions in which they occur in butter fat. On the large scale this operation is quite impracticable on account of cost, so that the art of the margarine manufacturer consists in utilizing the fats ready to hand, and blending them together in such proportions as most closely stimulate the natural product. This has been so successively achieved that many margarines resemble butter so closely in physical and chemical properties that the analyst has often difficulty in deciding whether a sample consists of true or artificial butter. There is some prospect that ultimately a margarine will be produced having almost exactly the same constituents as natural butter, and indistinguishable from it both by chemical tests and natural flavour.

The name margarine, first applied by the great French chemist, CHEVREUL, and derived from a greek word meaning "pearl," was chosen on account of the pearly or crystalline structure of margarine when seen under the microscope This crystalline structure often enables the analyst, by means of a microscope and polarized light, to distinguish margarine from butter when other tests are inconclusive. The term oleo-margarine is often used in America to indicate the substance which we in England call margarine. In accordance with the Margarine Act of 1877 all artificial butter must be sold under the name of "margarine," and such terms as "butterine" and "Dutch butter" are illegal. In Germany it was decreed by law that 10 per cent. of sesame oil must be used in order to facilitate chemical identification. During the last year or two, however, owing to the acute scarcity of oils and fats in Germany, it has not been possible to obtain the necessary sesame oil, and therefore a small percentage of potato meal has had to be introduced instead of sesame oil.

USE OF VEGETABLE OILS.

Animal fat was at first largely used for margarine manufacture, but lately, owing to the high prices of such fat, it is becoming more and more customary to use vegetable oils or fats, such as coconut oil, palm kernel oil, maize oil, wheat oil, and kapok seed oil. Mention may perhaps be made here of the important process of hydrogenation, or fat hardening. By means of this process, which owes its origin to the French chemists SABATIER and SENDERENS, liquid oil, such as cotton seed oil, linseed oil, etc., may be hardened into white solid fats, odourless and tasteless, like pure tallow. This process is capable of converting a comparatively inferior and low-grade oil, such as the lower grades (Nos. 3 or 4) of whale oil, into a solid white product, tasteless and odourless and with all the disagreeable qualities of the original whale oil entirely removed. Some have feared that low-grade oils have been hardened and utilized for margarine manufacture. So far as English brands

of margarine are concerned this fear is perfectly groundless. Such oils are used almost entirely for the manufacture of soap and for numerous other purposes in industry. The art of oil-refining, moreover, has made such rapid progress in England that all disagreeable constituents and qualities may be entirely removed and an absolutely unimpeachable product obtained. Moreover all the various processes, plant, and material used could, if necessary, be regulated by law and subjected to reasonable inspection.

Owing to the increasing use of vegetable oil and fats it has now become customary to divide margarines into two classes—(1) those containing chiefly animal fat as a basis, and (2) those containing a vegetable fat basis. This distinction has been emphasized by the Food Controller, who recently ordered that the maximum price of the animal-fat margarines should be 1*s.* 4*d.* per lb., whilst that of the vegetable-fat margarines should be 1*s.* per lb. It has been alleged that animal fat is intrinsically more valuable than vegetable fat because it contains certain growth-promoting constituents or vitamines. Numerous tests on rats and other animals show that they grow better on a diet containing these vitamines than on one from which the vitamines are absent. Full details are given in a recent issue of the Journal of Physiology and also in the Journal of Biological Chemistry (published in America). It is assumed that the results of these tests apply also to growing children. If the assumption that results obtained with animals are applicable to human beings is justifiable it must nevertheless be pointed out that animal fat is more liable to bacterial infection (e.g., tuberculosis) than vegetable fat. It should be by no means impossible to incorporate concentrated vitaminous preparations with vegetable fat margarine if necessary. Since, however, these vitamines are plentifully found in other articles of diet largely eaten by children, such as wholemeal bread, unpolished rice, fruit, vegetables, and eggs, the effect on growth of substituting vegetable-fat-margarine for butter or beef fat may be regarded as very nearly negligible.

SYNTHETIC MILK.

An important constituent in the manufacture of margarine is milk. On the average about 100 gallons are used to a ton of oil. It is, indeed, largely owing to a plentiful milk supply that the manufacture of margarine in Holland and Denmark has been so successful. Since only skimmed milk is used, the Danes and the Dutch have been able to utilize the cream for butter making, and have exported enormous quantities not only of margarine, but also of butter. . . . Moreover, the oil-cake from crushed oilseeds (or the meal resulting from chemical extraction of the oil) has been used for cattle feeding. In England conditions are not quite the same. All the milk produced here is wanted for domestic purposes, and until our farmers go in more largely for stall-feeding with cake, thus setting free thousands of acres of pasture for conversion into arable land without reducing the head of cattle, our margarine manufacturers will go short of milk and will have to pay increasingly higher prices. The alternative is to use synthetic or artificial milk, made largely from nuts, such as the groundnut and soya bean, and, from the point of view of food value and digestibility, equal if not superior to full cream milk and also very palatable. From the margarine manufacturer's point of view, it is greatly superior to milk, being less liable to bacterial infection, whereas natural milk has to be rigorously sterilized by pasteurisation or some other process—electrically or by means of ultra-violet rays.

It is estimated that the average weekly consumption of margarine in the United Kingdom is from 5,000 to 6,000 tons and would probably be more if supplies were available. About half the total amount consumed in 1916 was imported. There is, therefore, ample opportunity in this country for extending the industry and turning to profitable use our vast Imperial resources in oilseeds and nuts.

Several new factories have been and are being established in the neighbourhoods of London Liverpool and Hull. At Hull, the British Oil and Cake Mills have erected a margarine factory able to produce 200 tons of margarine and 200 tons of compound lard a week. It is hoped that some Government factories will soon be equipped and ready to begin work.

Between the years 1912 and 1915 an average of 200,000 tons of butter per annum was imported into this country, having a value of about £25,000,000. It was not until 1916 that there was any serious falling off in butter imports and a corresponding increase in margarine imports. The latter increased from 67,300 tons in 1912 to 137,000 tons (exclusive of oleo-margarine) in 1916. Our net imports of butter and margarine before the war were approximately 270,000 tons. Assuming that the consumption per head per annum before the war was 8½ lb. margarine and 17 lb. of butter, this is equal to 500,000 tons per annum.—THE TIMES TRADE SUPPLEMENT, March, 1918.

MANURIAL EXPERIMENTS WITH ARROWROOT.

Manurial experiments with arrowroot have been carried out in previous years, but the results have hitherto been inconclusive. It was therefore determined to plan an experiment in such a way as to yield definite results, and the principle adopted was to employ a large number of small plots, each $1\frac{1}{38}$ acre in area.

The experiments were conducted with two objects: (1) to test the value of mulching with prunings of Madre del Cacao (*Gliricidia maculata*), (2) to compare the relative value of various combinations of organic and artificial manures. In the first experiment the number of plots was twelve, of which four were mulched, and eight were left unmulched. Each mulched plot received an application of 40 lb. Gliricidia prunings. The average yield of the unmanured plots was at the rate of 9,565 lb. per acre, while the average yield of the mulched plots was 15,663 lb. per acre. This shows a gain by mulching of 6,098 lb. per acre, or 63·8 per cent. This increase from mulching is very striking.

In the second experiment nine different combinations of manure were applied to thirty-six plots, each combination being in quadruplicate. The average yield of the manurial plot indicates that, with the exception of the plot which received nitrogen, every plot shows a gain over the unmanured plots. The plots to which Gliricidia prunings were applied show a gain of 34 per cent. over the unmanured plots. A complete manure consisting of sulphate of potash, basic slag, and cotton-seed meal produced the next largest increase, namely 19 per cent.

The results, as a whole, indicate clearly that the arrowroot grower will at any rate be well advised to apply to the soil as much coarse organic material as possible.—REPT. ON THE AGRICULTURAL DEPT., ST. VINCENT, 1916-1917.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th APRIL, 1918.

Province.	Disease	No. of cases to date since Jan. 1st. 1918.	Fresh cases	Recoveries.	Deaths.	Balance ill.	No. shot.
Western	Rinderpest	32	7	9	21	2	—
	Foot & mouth disease	37	25	37	—	—	—
	Anthrax	2	—	—	2	—	—
	Swine Plague	30	—	—	30	—	—
	Rabies	1	1	—	1	—	—
Colombo Municipality	Rinderpest	9	—	—	—	—	—
	Foot & mouth disease	85	63	—	—	—	—
	Anthrax	1	—	—	—	—	—
	Rabies	6	4	—	—	—	—
Quarantine Station	Anthrax	979	312	—	—	—	—
Central	Foot & mouth disease	68	—	37	1	30	—
Northern	—	nil	—	—	—	—	—
North-Western	Rinderpest	8	—	3	5	—	—
	Foot & mouth disease	9	—	9	—	—	—
	Rabies	1	—	—	—	—	1
Eastern	Foot & mouth disease	203	20	183	20	—	—
Sabaragamuwa	Rabies	1	1	—	1	—	—
Uva	Foot & mouth disease	58	50	14	—	44	—
North-Central	Foot & mouth disease	3339	200	3294	45	—	—
Southern	Black-quarter	23	12	—	23	—	—

G. W. STURGESS, G.V.S.

METEOROLOGICAL.

APRIL, 1918.

Station.	Temperature: Mean Daily Shade	Temperature: Difference from average	Mean Humidity	Mean amount of cloud 0=clear. 10=Overcast	Mean Wind direction during month	Daily mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	82·1	-0·6	78	4·7	WSW	95	4·53	9	-2·91
Puttalam	82·2	-0·5	79	3·1	SW	125	2·08	4	-3·49
Mannar	85·4	+0·1	70	4·2	Variable	67	0·16	1	-2·58
Jaffna	85·7	-0·1	72	1·8	SW	258	0·00	0	-2·07
Trinco'mee	85·0	-0·2	71	3·4	Variable	94	0·13	1	-1·87
Batticaloa	82·6	-0·6	76	3·5	ESE	163	0·08	1	-1·82
Hambantota	81·2	-0·6	80	3·4	SW	204	1·47	10	-1·82
Galle	81·7	-0·2	80	4·5	Variable	113	4·82	10	-4·75
Ratnapura	82·2	-0·2	74	5·4	—	—	10·60	25	-1·91
Anu'pura	84·0	+0·4	70	5·6	—	—	5·99	10	-0·81
Kurunegala	82·8	-0·6	66	4·4	—	—	5·74	13	-3·52
Kandy	78·2	-0·8	72	5·5	—	—	2·74	10	-4·21
Badulla	74·0	-0·9	74	5·2	—	—	4·50	16	-3·12
Diyatalawa	67·6	-2·0	74	5·6	—	—	4·67	14	-0·85
Hakgala	60·7	-1·6	76	5·7	—	—	8·46	16	+1·49
N'Eliya	58·5	-2·0	76	5·9	—	—	6·14	15	+0·49

The Weather during the Month was hot and sultry and thunderstorms were frequent.

The rainfall for the greater part of the Island was in deficit as was the number of days on which rain fell. Rainfall above the normal was experienced upcountry around about Nuwara Eliya and in the N. C. P. just to the S. E. of Anuradhapura. In the extreme North little or no rain was experienced.

Temperature, humidity and cloud amount were mostly below normal, while the wind strength to the South East of the Island was above normal and below to the West.

J. E. EVANS,
Acting Supdt., Observatory.

MARKET RATES FOR TROPICAL PRODUCTS.

(From Lewis & Peat's Latest Monthly Prices Current.)

	QUALITY.	Quotations.
ALOES, Soccotrine cwt.	Fair to fine	110/ a 120/
Zanzibar & Hepatic „	Common to good	40/ a 105/
ARROWROOT (Natal) lb.	Fair to fine	9d a 9½d
BEES' WAX cwt.		
Zanzibar Yellow „	Slightly drossy to good	£9 a £9 5/ nom.
East Indian bleached „	Fair to good	£11 12/6 a £12 „
„ unbleached „	Dark to good genuine	£8 15/ a £9 „
Madagascar „	Dark to good palish	£9 a £9 7/6 „
CAMPHOR, Japan lb.	Refined	3/10 a 4/3
China cwt.	Fair average quality	Nominal
CARDAMOMS, Tuticorin	Good to fine bold	3/6 a 4/6 nom.
per lb.	Middling lean	2/ a 2/9 „
Malabar, Tellicherry „	Good to fine bold	3/ a 4/ „
Calicut „	Brownish	1/9 a 2/6 „
Mangalore „	Med Brown to good bold	2/6 a 5/3 „
Ceylon, Mysore „	Small fair to fine plump	2/ a 5/
Malabar „	Fair to good	1/7 a 1/8
Seeds, E. I. & Ceylon „	Fair to good	2/3 a 2/6
Ceylon "Long Wild" „	Shelly to good	1/ a 1/6 nom
CHILLIES, Zanzibar cwt.	Dull to fine bright	75/ a 85/
Japan „	Fair bright small	60/ a 70/
CINCHONA BARK.—lb. Ceylon	Crown, Renewed	3⅜d a 7d
	Org. Stem	2d a 6d
	Red Org. Stem	1⅜d a 4¼d
	Renewed	3d a 5¼d
	Root	1⅞d a 4d
CINNAMON, Ceylon 1sts.	Fair	2/6
per lb. 2nds.	„ „	2/3
3rds.	„ „	2/
4ths.	„ „	11d
Chips,	Fair to fine bold	10⅜d a 1/
CLOVES, Penang lb.	Dull to fine bright pkd.	3/6 a 4/
Amboyna „	Dull to fine	2/ a 2/6
Zanzibar „	Fair and fine bright	1/9 a 2/
Madagascar „	Fair	1/9 a 1/10
Stems „	Fair	7½d
COFFEE		
Ceylon Plantation cwt.	Medium to bold	Nominal
Liberian „	Fair to bold	„
COCOA, Ceylon Plant. „	Special Marks	87/ a 95/
	Red to good	80/ a 88/
Native Estate	Ordinary to red	50/ a 83/
Java „	Small to good red	70/ a 100/
COLOMBO ROOT „	Middling to good	160/ a 170/
CROTON SEEDS, sifted „	Dull to fair	70/ a 75/
CUBEBS „	Ord. stalky to good	£16/ a £17/ 10/
FIBRE, Kitul lb.	OOO good long	10d a 11d [nom.
	OO „ medium	8½d
	No. 1 fair	7d
Palmyrah ton.	Common to fair	£30/ a £35 nom.
„	Medium to good med	£40/ a £45 „
	Good to fine	£50/ a £60 „
GINGER, Bengal, rough cwt.	Fair	62/6
Calicut, Cut A „	Medium to fine bold	100/ a 110/
B & C „	Small and medium	90/ a 100/
Cochin, Rough „	Common to fine bold	67/6 a 72/6
	Small and D's	67/6
Japan „	Unsplit	52/6 a 55/
GUM Ammoniacum „	Ord. blocky to fair clean	175/ a 200
Animi, Zanzibar	Pale and amber, str. srts	£14 10/ a £16 10/
„	„ „ little red	£11 a £12
„	Bean and Pea size ditto	70/ a £11
„	Fair to good red sorts	£8 10/ a £10 10/
„	Med. and bold glassy sorts	£5 10/ a £7 5/
Madagascar „	Fair to good palish	£4 a £8
„	„ „ red	£4 a £7
Arabic, E. I. & Aden „	Ordinary to good pale	55/ a 75/
Turkey sorts „	... ...	85/ a 87/6
Ghatti „	Sorts to fine pale	30/ a 50/
Kurrachee „	Reddish to good pale	35/ a 50/ nom.
Madras „	Dark to fine pale	30/ a 45/ nom.
Assafœtida „	Clean fr. to gd. almonds	£15 a £20
	com. stony to good block	£4 a £10
INDIGO, E.I. Bengal lb.	Shipping mid to gd. violet	10/ a 12/6
„	Consuming mid. to gd.	9/ a 10/
„	Ordinary to middling	7/6 a 9/
„	Mid. to fine Kurpah	7/ a 9/
„	Low to ordinary	4/6 a 6/9
„	Mid. to fine Madras	2/6 a 4/6
KAPOK lb.	Ordinary to good	1/ a 1/4
KINO lb.	Fair to fine bright	6d a 1/5
MACE, Bombay & Penang per lb.	Pale reddish to fine	3/6 a 4/
	Ordinary to fair	3/ a 3/6
Java	„ „ good pale	3/3 a 4/
Bombay	Wild	8d
MYRRH Aden sorts cwt.	Middling to good	190/ a 210/
Somali „	„ „	160/ a 180/

	QUALITY.	Quotations.
NUTMEGS,— lb.		
Singapore & Penang „	64's to 57's	2/ a 2 6
	80's	1/11
	110's	1/6
NUX VOMICA, Cochin	Ordinary to good	42/6 a 45/
per cwt. Bengal	„ „	40/ a 42/
Madras	„ „	40/ a 43/
OIL OF ANISEED lb.	Fair merchantable	4/2
CASSIA „	According to analysis	6/ a 6/6
LEMONGRASS oz.	Good flavour & colour	4⅛d
NUTMEG „	Dingy to white	1½d a 1⅞d
CINNAMON (Ceylon)	Ordinary to fair sweet	6d a 2s 6d
CITRONELLE „ lb.	Bright & good flavour	2/8
OLIBANUM, drop cwt	Good to fine white	130/ a 150/
„	Middling to fair	100/ a 120
pickings „	Low to good pale	22/6 a 40/
siftings „	Slightly foul to fine	35/ a 45/
ORCHELLA WEED—cwt		
Ceylon „	Fair	10/6
Madagascar „	Fair	10/6
Zanzibar „	Fair	10/6
PEPPER—(Black) lb.		
Alleppy & Tellicherry	Fair	1/3 a 1/3½
Ceylon „ „	Fair to fine bold heavy	1/2 a 1/4
Singapore ...	Fair	1/2
Acheen & W. C. Penang	Dull to fine	1/2
(White) Singapore „	Fair to fine	1/7 a 1/7½
Siam „	Fair	1/8¼
Penang „	Fair	none
Muntok „	Fair	1/8½
RHUBARB, Shenzi „	Ordinary to good	1/8 a 3/
Canton „	Ordinary to good	1/6 a 2/6
High Dried „	Fair to fine flat	2/ a 2/3
RUBBER, INDIA lb.	Standard smoked sheets	2/3½
Ceylon, Straits, „	Standard Crepe	2/4½
Malay Straits, etc. „	Scrap fair to fine	1/9½
Assam „	Fair 11 to ord. red No. 1.	1/4
Rangoon „	„ „ „	1/6
Borneo „	Common to good	1/6
Java „	Good to fine red	1/8 a 1/10
Penang „	Low white to prime red	1/6 a 1/9
Mozambique „	Sausage, fair to good	1/6 a 2/
Nyassaland „	Fair to fine ball	1/6 a 2/
Madagascar „	Fr. to fine pinky & white	1/4 a 1/7
	Majunga & blk coated	1/
„	Niggers, low to good	9d a 1/6
New Guinea „	Ordinary to fine ball	1/6 a 2/
SAGO, PEARL, large—cwt	Fair to fine	65/ a 70
medium ...	„ „	65/ a 70/
small ...	„ „	65/ a 70/
Flour ...	Good pinky to white	75 a 77/6
SEEDLAC cwt.	Ordinary to gd. soluble	225/ a 250/ nom.
SENNA, Tinnevelly lb.	Good to fine bold green	9d a 10d
	Fair greenish	5½d a 8d
	Common specky & small	3d a 4½d
SHELLS, M. of PEARL—		
Egyptian cwt.	Small to bold	40/ a £5 10/ nom
Bombay „	„ „	55/ a £5 15/ „
Mergui „	Chicken to bold	£6 15/ a £14 „
Manilla „	„ „	£6 a £10/ nom
Banda „	Sorts	40/ a 45/ „
Green Snail „	Small to large	50/ a 75/ „
TAMARINDS, Calcutta...	Mid to fine bl'k not stony	45/ a 50/
per cwt. Madras	Inferior to good	25/ a 35/
TORTOISE SHELL—		
Zanzibar & Bombay lb.	Small to bold	10/ a 25/
	Pickings	5/ a 15/
Ceylon	Small to bold	10/ a 22/
Mauritius & Seychelles	„ „	10/ a 25/
TURMERIC, Bengal cwt.	Fair	50/
Madras „	Finger fair to fine bold	60/ a 65
Do. „	Bulbs „ „ [bright	45/ nom.
Cochin „	Finger fair	50/ nom.
	Bulbs „	37/6
VANILLA.— lb.		
Mauritius ... 1sts.	Gd. crystallized 3½a 8½ in.	5/6 a 9 6
Madagascar ... 2nds.	Foxy & reddish 3½a „	5/ a 7/
Seychelles ... 3rds	Lean and inferior	5/ a 5/9
WAX, Japan, squares, cwt.	Good white hard	102/5

Photo by John & Co., Kandy.

DEDIGAMA AGRICULTURAL SHOW.

Show Favilions.